GEOPHYSICAL SURVEYS FOR ASSISTING IN DETERMINING THE GROUND WATER RESOURCES HONOMALINO AND KAPUA AREAS ISLAND OF HAWAII

Blackhawk Geometrics Project Number 9837MHI

Prepared For:
MACFARMS OF HAWAII, INC.

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November 11, 1998

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1.0 INTRODUCTION

This report contains the procedures and results of geophysical surveys conducted to assist in determining the ground water resources on properties in the Honomalino and Kapua areas, Island of Hawaii. The surveys were performed by Blackhawk Geometrics (Blackhawk) for MacFarms of Hawaii, Inc. (MacFarms) during October 5 to October 9, 1998. The geophysical method employed during this survey was Time Domain Electromagnetic (TDEM) soundings. During these surveys, TDEM soundings were located on Hawaii State Parcel TMK 8-9-1-02 and on property owned by MacFarms as shown on Figure 1-1. TDEM data previously acquired in a 1990 survey for MacFarms has been incorporated into this report.

The Honomalino and Kapua areas of Hawaii are in the South Kona District in the southwest portion of the island. The main geologic feature in this area of the Island of Hawaii is the southwest rift zone, which extends away from the summit of Mauna Loa Volcano to the coastline near South Point (Stearns and Macdonald, 1946). The nearest mapped volcanic cone (Puu Ohohia) associated with the southwest rift zone, is located approximately five miles east of the study area.

The main objective of the geophysical survey was to assist in characterizing the hydrologic regime in the Honomalino and Kapua areas for a proposed ground water well. Ground water resources can occur on the Island of Hawaii basically in two modes:

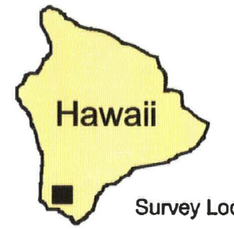
- In a basal mode, where a lens-shaped body of fresh water floats on saline water, and
- In a high-level mode, where the ground water occurrence is controlled by subsurface damming structures.

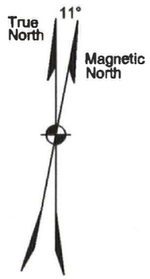
These two types of ground water occurrences are illustrated in Figure 1-2. The surficial volcanic rocks are generally highly permeable and this allows rainwater to infiltrate directly downward through the island mass. The basal ground water lens extends from the outer edges of subsurface structures (i.e., dikes) to a discharge area near the shoreline. In the Honomalino and Kapua areas, ground water was expected to occur as a deep basal fresh-brackish water lens.

Previous TDEM surveys on the Hawaiian Islands have reliably mapped the boundary between fresh water in the basal mode and high-level water occurrences. Geophysical surveys, combined with other hydrogeologic information, are used to provide optimum locations for well placement and completion depths.

Explanation

- 98-1 — 1998 TDEM Soundings
- 1N1E — 1990 TDEM Soundings
- Kapua (5.0') — Well, Water Level (Ft.)





0 2000 4000 6000

Scale in Feet
Contour Interval 40 Feet

BLACKHAWK GEOMETRICS

Location Map
Honomalino & Kapua Areas

MacFarms of Hawaii, Inc.
Captain Cook, Hawaii

Project No. 9837 Figure: 1-1

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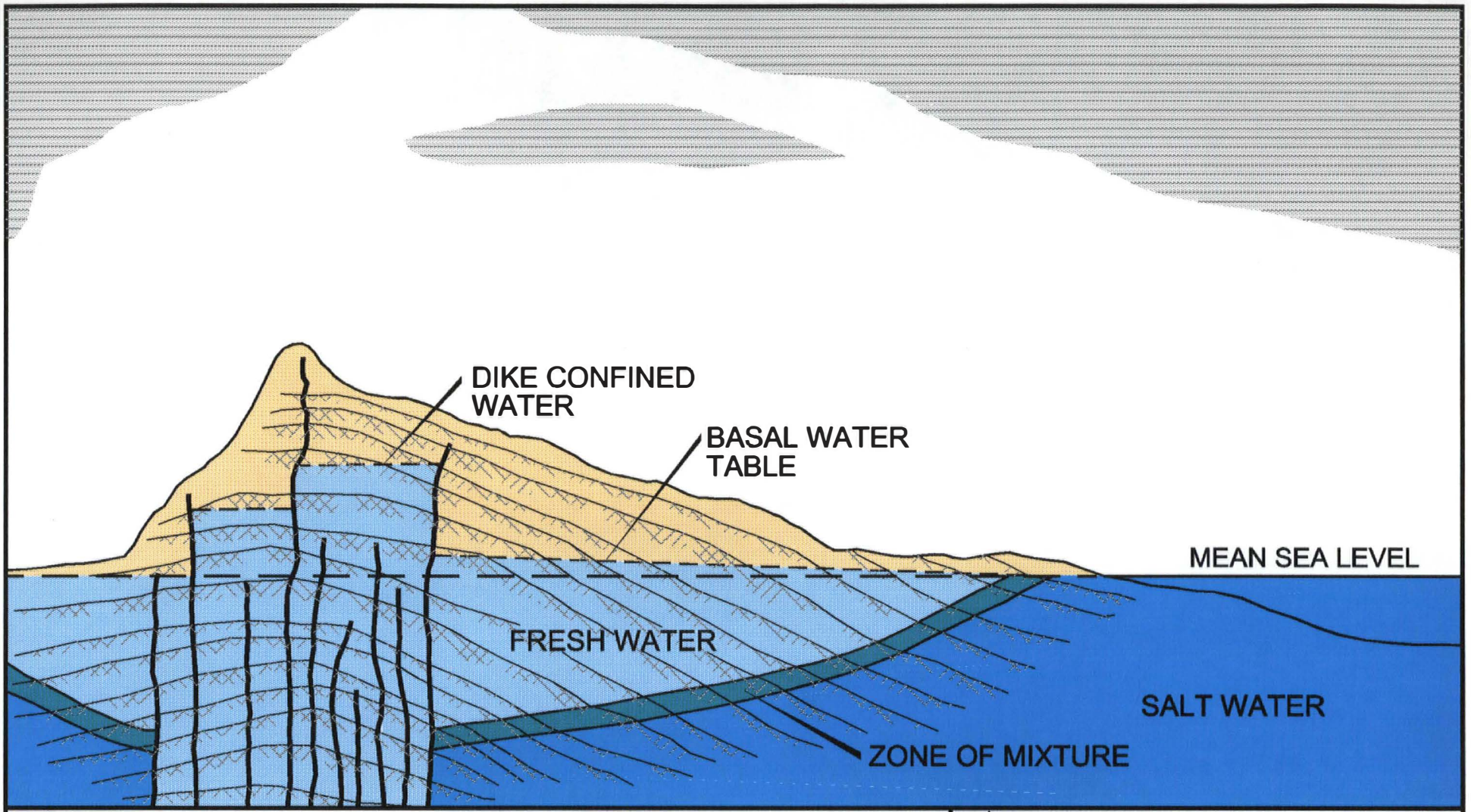

BLACKHAWK GEOMETRICS

Schematic Hydrogeologic Cross Section

MacFarms of Hawaii, Inc.
Captain Cook, Hawaii

Project No. 9837 Figure: 1-2

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2.0 DATA ACQUISITION AND LOGISTICS

The geophysical equipment used for the Time Domain Electromagnetic (TDEM) surveys was the Geonics EM37 System. The EM37 system consists of both a portable transmitter and receiver. TDEM measurements at study area were acquired using a central-loop sounding array at each site. With this array, measurements are recorded with a receiver at the center of transmitter loops laid on the ground surface. The transmitter loops are constructed with 12-gauge insulated copper wire. The dimensions of the square loops at the Honomalino and Kapua sites varied from 1000 ft by 1000 ft to 1700 ft by 1700 ft. A 2.8 kW transmitter was placed in each sounding loop to drive current ranging between 13 and 15.5 amperes at base frequencies of 3 Hz and 30 Hz. At the center of each transmitter loop, the time derivative of the vertical magnetic field was recorded with a circular receiver coil with an effective area of 100 m^2. For data quality control, offset comparison measurements are also made at designated locations near the center of each sounding. The data acquired at each sounding consisted of measurements at several receiver gain settings and two transmitter frequencies in order to assure data quality and to obtain data over the largest time interval possible. A problem with the TDEM receiver occurred during the survey, but it was resolved and repeat measurements of data proved comparable throughout the survey. The data from each sounding was stored in the field on an Omnidata polycorder and, subsequently, transferred to a PC for nightly processing. A technical note describing the principles of TDEM with case histories is given in Appendix A.

TDEM sounding loop locations were measured by compass and hip-chain from known landmarks (i.e., rock walls, roads). A total of 3 TDEM soundings were accomplished during this survey. A daily log of field activity is given in Table 2-1. The elevation of each sounding center was measured using an Avocet Vertech Altimeter/Barometer. The altimeter was adjusted during the course of a day at known landmarks (i.e., road junctions) with altitudes taken from a 7.5 minute series topographic map of the Honomalino area. The sounding loop locations were selected by representatives of MacFarms and Blackhawk. The designated locations were based on available state land access and exploration objectives.

TABLE 2-1 DAILY LOG OF FIELD ACTIVITIES	
DATE, 1998	**ACTIVITY**
September 23	Mobilize geophysical equipment from Golden, CO, to Kona, HI.
September 28	Mobilize Blackhawk Geometrics personnel from Golden, CO, to Kona, HI. Retrieve geophysical equipment from air cargo and organize into field vehicles.
September 29-October 4	Data taken on other Hawaii project.
October 5	Meet with MacFarms Orchard Manager and field representative. Discuss survey procedures and recon survey site. Lay-out wire loop on Sounding 98-1 and acquire data.
October 6	Repeat data on Sounding 98-1 in reference mode. Pick up wire loop and begin laying out Sounding 98-2. Able to lay out only three wires of loop because of thick undergrowth.
October 7	Finish laying out wire and acquire data on Sounding 98-2 in both crystal and reference modes.
October 8	Discuss TDEM data results with MacFarms manager and consulting hydrologist. Decide to take additional data on MacFarms property. Lay out wire and take data on Sounding 98-3.
October 9	Repeat data on Sounding 98-3. Pick up wire and demob from site. No charge for this day of field work.
October 10	Take data on other Hawaii project.
October 11-12	Demobilize geophysical equipment and Blackhawk personnel from Kona, Hi, to Golden, CO.

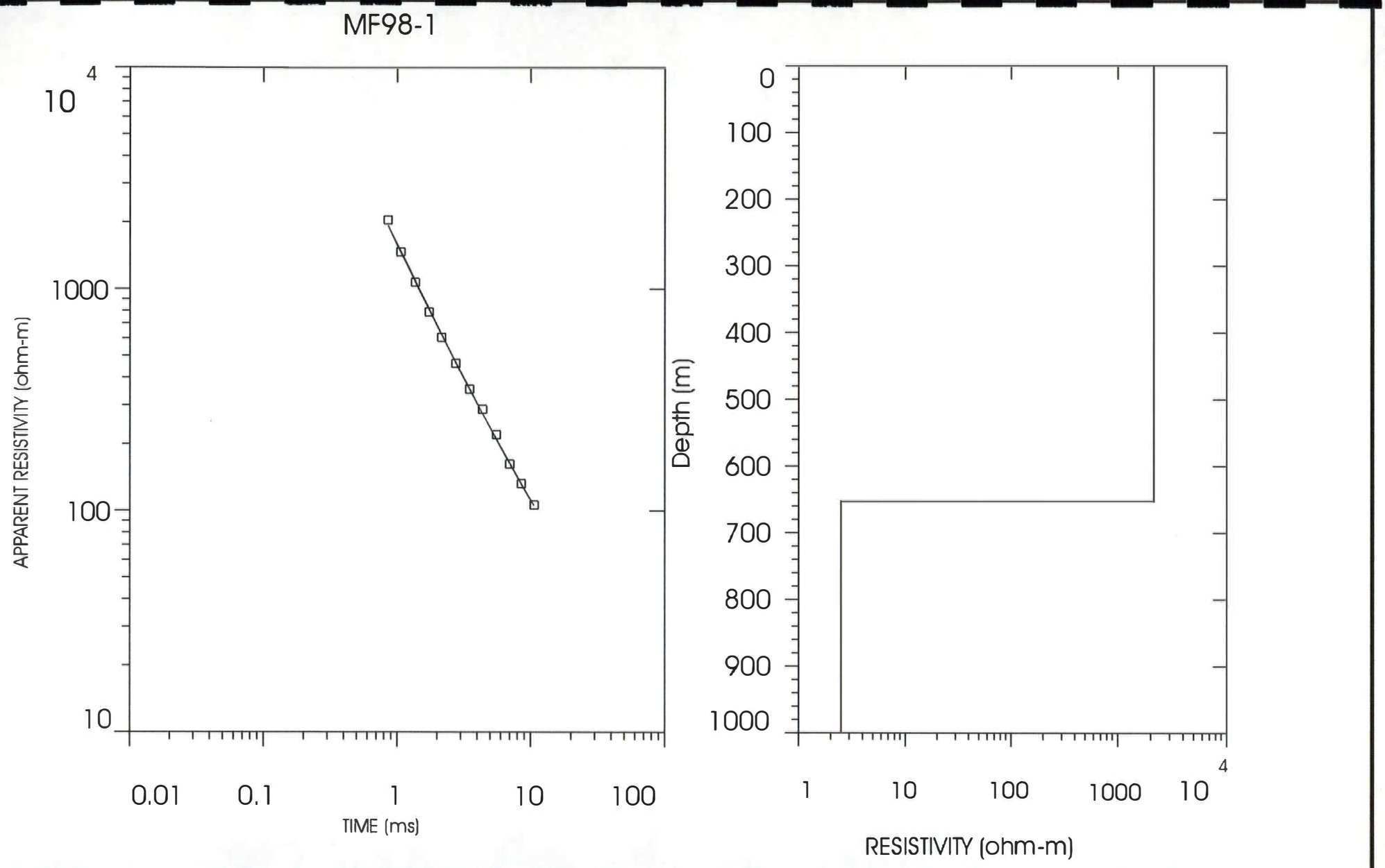
3.0 DATA PROCESSING

The TDEM field data acquired each day were transferred from the Omnidata polycorder to a PC. The first step in processing the TDEM data is to average the electromotive forces (emfs) recorded at positive and negative receiver polarities in the center of each sounding. Next, the recordings made at different amplifier gains and frequencies were combined to give one transient decay curve with the program TEMIXXL (Interpex LTD). With this program, voltages measured with the 20 channels of the Geonics EM37 receiver are transformed into apparent resistivity verses time gate. The apparent resistivity curve is interpreted by inversion to a one dimensional (1-D) geoelectric section that matches the observed decay curve.

The TEMIXXL inversion program requires an initial estimate of the geoelectric section, including the number of layers and the thicknesses and resistivities for each of the layers. The program then adjusts these parameters so that the model curve converges to best fit the curve formed by the field data. The inversion program does not change the number of layers within the model, but allows all other parameters to change freely, or they can optionally be fixed constant. To determine the influence and best fit of the number of layers on the solution, separate inversions with different (increased and decreased) numbers of layers are run. Normally, the model with the fewest number of layers which best fits the data is used.

An example of the output of the inversion program (Sounding MF98-1) is shown on Figures 3-1 and 3-2. Figure 3-1 shows the measured data points (in terms of apparent resistivity) superimposed on a solid line. The solid line represents the computed forward model of the geoelectric section shown on the right. Figure 3-2 shows the tabulated inversion parameters and results consisting of measured field data, computed data for best match solution, and inversion errors. A two-layer model is shown for Sounding MF98-1 with the first layer of the model having a high resistivity of 2149 ohm-m and a thickness of 2142 ft (652.8 m). The second layer of the model shows a resistivity of 2.5 ohm-m, and it represents saline water saturated volcanics in the section. The resistivity calculated for saline saturated volcanics at Sounding MF98-1 was 2.48 ohm-m. Because it is the depth to this saline layer that is the primary objective of this study, the low resistivity layer can be fixed at 2.5 ohm-m for all of the data in this survey.

The apparent resistivity curves and data sheets for the TDEM soundings for both the 1990 and 1998 surveys are given in Appendix B.



BLACKHAWK GEOMETRICS

TDEM Inversion Results
Sounding MF98-1
MacFarms of Hawaii, Inc.
Captain Cook, Hawaii

Figure: 3-1

Project No. 9837

\projects\9837mhi\Results1.cdr

DATA SET: MF98-1

CLIENT: MACFARMS OF HAWAII
DATE: 10-05-98
LOCATION: HONOMALINO
SOUNDING: 1E
COUNTY: SOUTH KONA
ELEVATION: 567.00 m
PROJECT: TDEM SURVEY
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 305.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 1.0000 N: 100.0000
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 4.274 PERCENT

L #	RESISTIVITY (ohm-m)		THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
				567.0	
1	2148.7		652.8	-85.89	0.303
2	2.50	*			

"*" INDICATES FIXED PARAMETER

CURRENT: 14.70 AMPS
EM-37
COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz
GAIN: 7
RAMP TIME: 165.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.857	10.85	11.79	-8.68
2	1.06	10.37	10.28	0.874
3	1.37	8.90	8.67	2.62
4	1.74	7.76	7.39	4.85
5	2.17	6.65	6.32	5.07
6	2.77	5.42	5.30	2.33
7	3.50	4.49	4.44	1.21
8	4.37	3.53	3.73	-5.54
9	5.56	2.87	3.06	-6.50
10	6.98	2.57	2.52	2.22
11	8.56	2.09	2.09	0.125
12	10.64	1.70	1.70	0.00233

PARAMETER RESOLUTION MATRIX:

"F" INDICATES FIXED PARAMETER

P 1	0.03		
F 2	0.00	0.00	
T 1	0.01	0.00	1.00
	P 1	F 2	T 1

BLACKHAWK GEOMETRICS

TDEM Inversion Results
Sounding MF98-1
MacFarms of Hawaii, Inc.
Captain Cook, Hawaii

Figure: 3-2

Project No. 9837

\projects\9837mhi\Results2.cdr

4.0 INTERPRETATION RESULTS

4.1 General

The primary objective of the TDEM soundings is to derive the resistivity layering (geoelectric section) of the subsurface. The translation of resistivity layering into hydrologic information is generally accomplished by two methods. These include:

1) Using available knowledge about the relation between resistivity values and local hydrology. From more than 35 previous TDEM surveys on the Hawaiian Islands, it has been observed that volcanic rocks saturated with salt water exhibit resistivities typically less than 5 ohm-m. Conversely, volcanic rocks that are dry and unweathered or fresh water saturated, exhibit high resistivities (generally greater than 500 ohm-m). Weathered volcanics or ash flows and intrusives often exhibit intermediate resistivities (about 10 ohm-m to 100 ohm-m). Generally, it is difficult to discriminate between dry volcanic rocks and fresh-brackish water (less than 250 ppm chloride) saturated volcanic rocks. The main reasons are that, in addition to salinity, changes in porosity and lithology also influence formation resistivity.

   Applying this information, characteristic ranges of resistivities expected for local hydrogeologic units for the Honomalino and Kapua areas are shown in Figure 4-1. It should be noted that some overlap in resistivity values occur. In these cases, other factors are used to infer the geologic/hydrologic unit in question. For example, a low resistivity unit (i.e., less than 10 ohm-m) occurring at an elevation above sea level is assumed to be caused by either weathered rock units or intrusives (i.e., dikes) instead of salt water saturated formations.

2) Another method is to calibrate the geophysical interpretation at a well. A comparison of the results of Sounding 1N1E to the Kapua Well during the 1990 survey was made. The estimated thickness of the fresh-brackish water lens derived from Sounding 1N1E is 203 ft (5.1 ft head) and the reported head for the Kapua Well is 5.0 ft (Nance,1998), showing good correlation between the TDEM data and well information. This was the only well in the project area that was used for comparison.

Where a very conductive layer (less than 5 ohm-m) is detected below sea level in the TDEM measurement, the layer is interpreted to be caused by salt water saturated volcanics. Static fresh water levels (head) can be calculated from these soundings by using the Ghyben-Herzberg relation as illustrated in Figure 4.2. The Ghyben-Herzberg relationship states that for every 1 ft of fresh water above sea level, approximately 40 ft of fresh water will exist below sea level. However, hydrostatic equilibrium is assumed for these measurements, and this relationship is not expected to apply to soundings in close proximity to geologic structures (i.e., dikes, rift zones), which act to alter ground water flow.

4.2 Hydrogeologic Interpretation

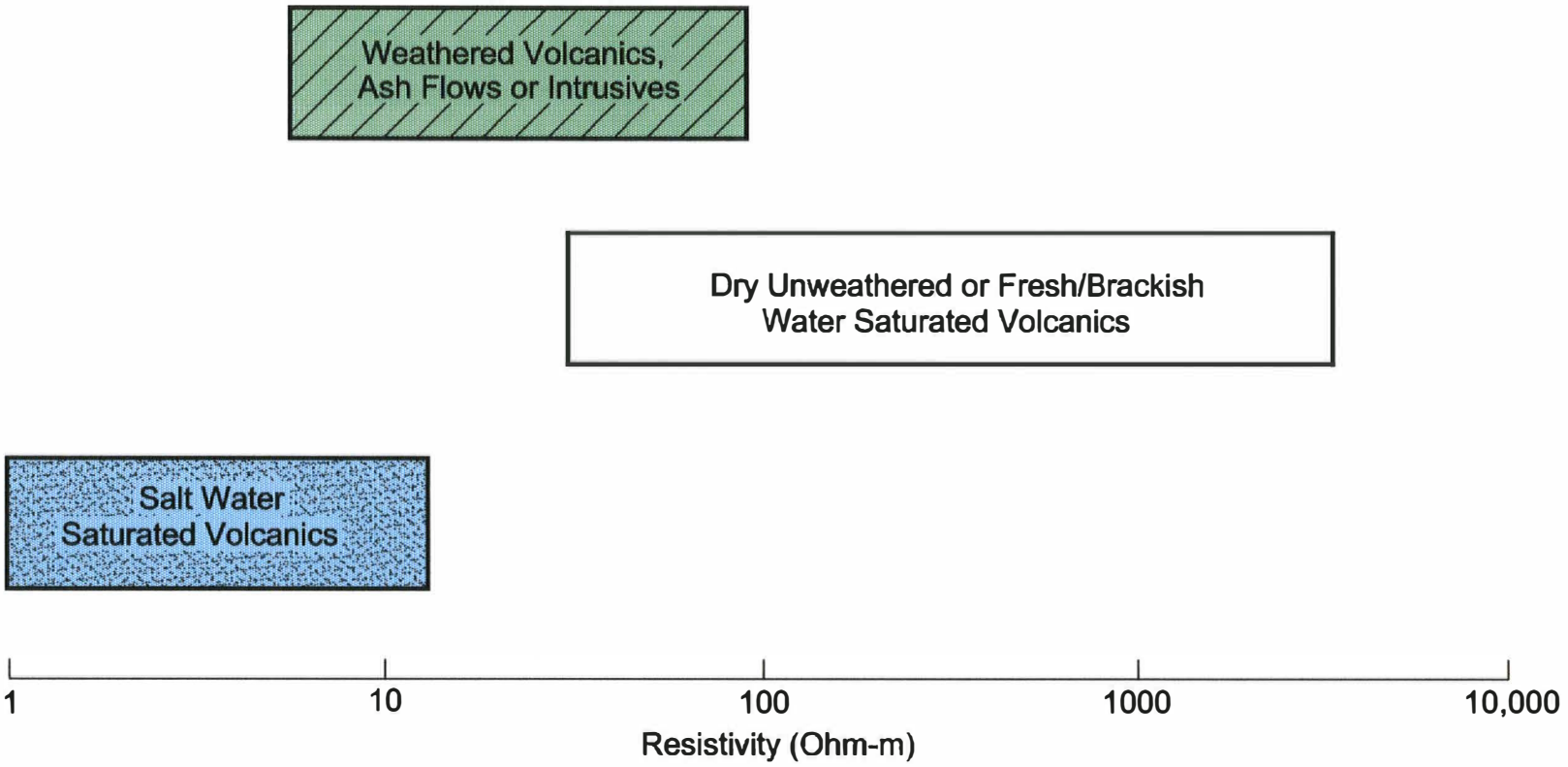
The results of the previous 1990 TDEM surveys have been incorporated into this report. Beneath all of the TDEM soundings from both the 1990 and the 1998 data sets, salt water saturated volcanics were detected below sea level. The fresh-brackish water resource can be estimated in these soundings by the volume between sea level and the interpreted elevation of salt water interface, plus the head calculated from the Ghyben-Herzberg relationship. Table 4-1 shows the thickness of the fresh-brackish water lens interpreted directly from the model results and the calculated head for each sounding.

TABLE 4-1
HYDROGEOLOGIC INFORMATION
DERIVED FROM TDEM SOUNDINGS

Sounding Number	Surface Elevation (ft)	Calculated Head Above Sea Level (ft)	Estimated Thickness of Fresh-Brackish Water Lens (ft)
98-1	1860	7.1	289
98-2	2285	10.5	432
98-3	2500	11.6	475
1N1E	1220	5.1	208
1N2E	1840	?	?
1N3E	2235	6.3	257
1N4E	1920	5.6	230
2N2E	1850	5.8	236
2N3E	2240	6.8	280
3N2E	1890	8.6	354
3N3E	2350	8.4	344
4N2E	1900	9.3	379
4N3E	2330	10.8	442

The accuracy of determining the depth to the salt water interface from TDEM soundings is estimated to be ±5% of the total depth calculated in the sounding result (e.g., from the ground surface to salt water interface).

The results of the TDEM investigations, from 1990 and 1998, are incorporated into the interpretation summary map shown on Figure 4-3. This map shows contours of head thickness (ft) calculated from the 12 TDEM soundings. In some areas of the map, the contours are approximate (dashed) because of the low station density. The map shows a northeast trending ridge of higher ground water head from Sounding 4N2E to Sounding 98-3. Steep gradients in head are observed both south and north of this ridge. The ridge in ground water head may be caused by increased porosity and/or permeability in volcanic layers beneath this area which allows preferential ground water flow and build up of the fresh-brackish water lens in this area.



BLACKHAWK GEOMETRICS

Characteristic Resistivity Ranges

MacFarms of Hawaii, Inc.
Captain Cook, Hawaii

Project No. 9837 Figure: 4-1

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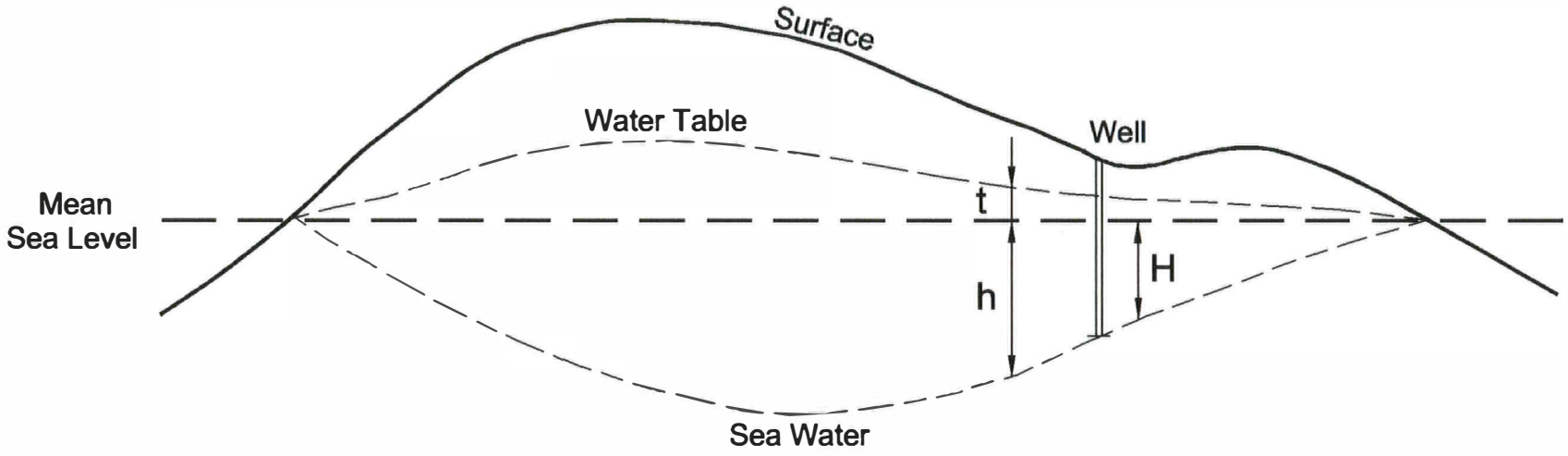


t = 1/40 (h)

From: Herzberg

BLACKHAWK GEOMETRICS

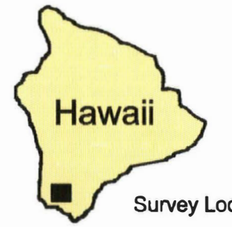
Illustration of the
Ghyben-Herzberg Principle
MacFarms of Hawaii, Inc.
Captain Cook, Hawaii

Project No. 9837 Figure: 4-2

\projects\9837mhi\WtrXsec.dwg

Explanation

- 98-1 — 1998 TDEM Soundings
- 1N1E — 1990 TDEM Soundings
- Kapua (5.0') — Well, Water Level (Ft.)
- (11.6') — Calculated Head (ft.) from TDEM Soundings
- Contours of Head Thickness (Ft.)



Survey Location

0 2000 4000 6000

Scale in Feet
Contour Interval 40 Feet

BLACKHAWK GEOMETRICS

TDEM Summary Map
Honomalino & Kapua Areas

MacFarms of Hawaii, Inc.
Captain Cook, Hawaii

Project No. 9837 Figure: 4-3

\projects\9837mhi\SumMap.dwg

5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the TDEM surveys in the Honomalino and Kapua areas for MacFarms of Hawaii,1990 and 1998, are combined and shown in Figure 4-3. The data indicate that beneath all soundings a lens of basal mode fresh-brackish water occurs. The highest head is interpreted to occur beneath Sounding 98-3 (11.6 ft). A northeast trending ridge of higher ground water head is interpreted from about Sounding 4N2E to Sounding 98-3. Along this ridge, groundwater heads are interpreted to be much greater than soundings at similar elevations away from the ridge. For example, Sounding 4N2E (elevation 1900 ft) shows a calculated head of 9.3 ft, and Sounding 2N2E (elevation 1890 ft) shows a calculated head of 5.8 ft. The exact cause of the apparent ridge is unknown, but it may be caused by increased permeability and porosity of volcanic formations in these areas. The extension of the ridge to the southwest of Sounding 4N2E is not well defined with the existing TDEM data coverage.

Sounding 1N1E, taken upslope from the Kapua Well, showed good comparison of calculated head from TDEM data (5.1 ft) to the measured head of 5.0 ft.

To improve the reliability of the contours of head thickness, additional TDEM soundings are recommended in areas of limited data. TDEM soundings combined with other hydrogeologic information have proven to be useful in determining optimum locations for well locations and completion depths.

REFERENCES

1. Davis, S. N., DeWiest, R. J. M., 1966. Hydrogeology, ground water in igneous rocks, pp. 333-343.
2. Langenheim, V.A.M., Clague, D.A.,1987. Stratigraphic framework of volcanic rocks of the Hawaiian islands, Chap 1, Volcanism in Hawaii: U.S. Geological Survey Professional Paper 1350, Vol. 1, pp. 55-73.
3. Stearns, H. T., Macdonald, G. A., 1946. Geology and ground-water resources of the Island of Hawaii, Hawaii Division of Hydrography Bulletin 9, pp. 220-227.

M1N1E

MODEL: 3 LAYERS

RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	ELEVATION (FEET)	CONDUCTANCE (S) LAYER	CONDUCTANCE (S) TOTAL
		371.9	1220.0		
1084.92	257.6	114.2	374.8	0.2	0.2
89.47	176.2	-62.0	-203.3	2.0	2.2
2.52					

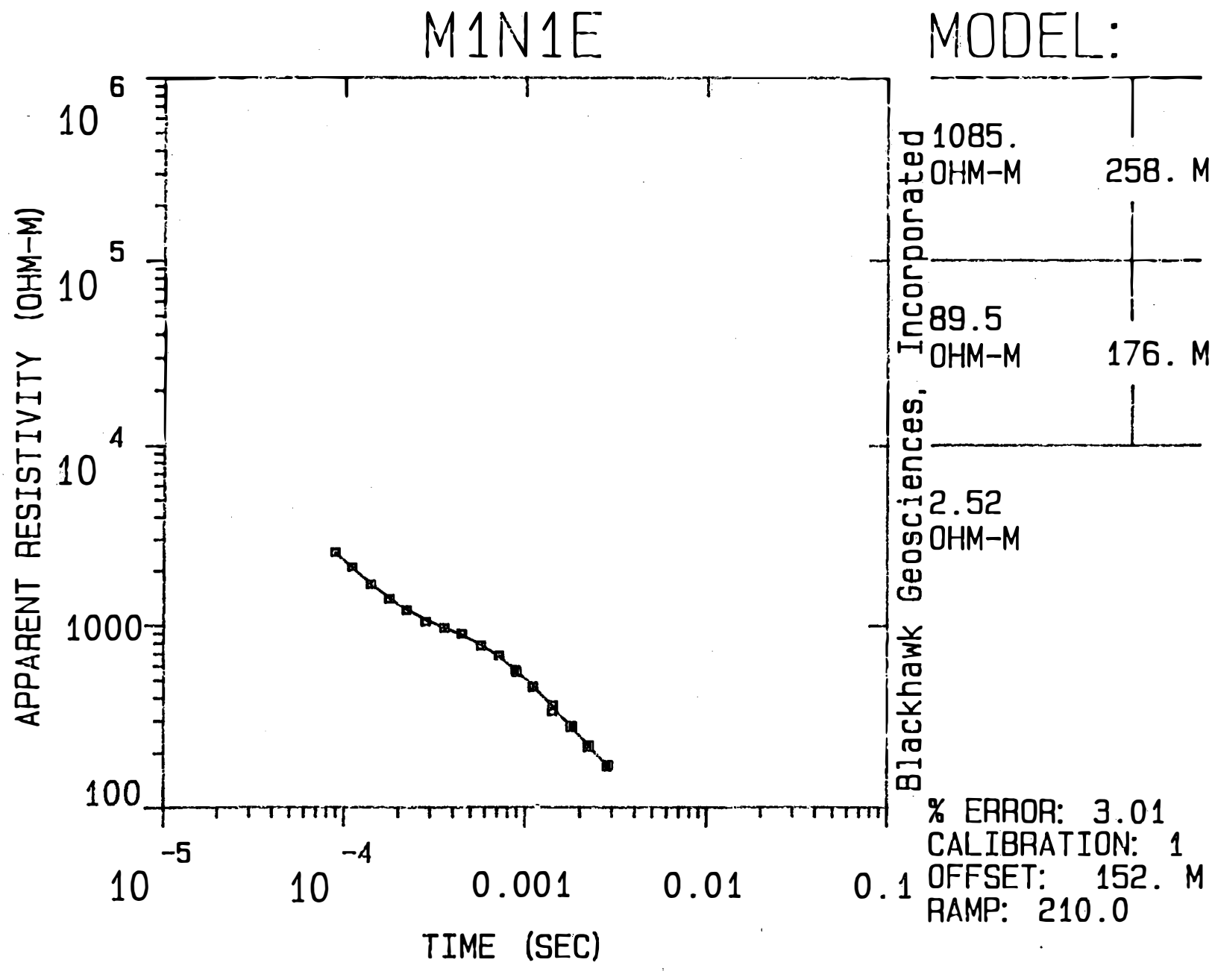
	TIMES	DATA	CALC	% ERROR	STD ERR
1	8.90E-05	2.54E+03	2.53E+03	0.647	
2	1.10E-04	2.10E+03	2.08E+03	0.756	
3	1.40E-04	1.68E+03	1.69E+03	-0.277	
4	1.77E-04	1.40E+03	1.41E+03	-0.637	
5	2.20E-04	1.21E+03	1.22E+03	-0.604	
6	2.80E-04	1.05E+03	1.07E+03	-2.008	
7	3.55E-04	9.71E+02	9.64E+02	0.772	
8	4.43E-04	8.97E+02	8.78E+02	2.171	
9	5.64E-04	7.74E+02	7.81E+02	-0.911	
10	7.13E-04	6.84E+02	6.73E+02	1.652	
11	8.81E-04	5.69E+02	5.68E+02	0.264	
12	8.90E-04	5.52E+02	5.63E+02	-1.840	
13	1.10E-03	4.63E+02	4.62E+02	0.120	
14	1.10E-03	4.57E+02	4.61E+02	-0.722	
15	1.40E-03	3.38E+02	3.59E+02	-5.840	
16	1.41E-03	3.66E+02	3.56E+02	2.657	
17	1.77E-03	2.78E+02	2.79E+02	-0.579	
18	1.80E-03	2.82E+02	2.75E+02	2.354	
19	2.20E-03	2.16E+02	2.21E+02	-2.180	
20	2.22E-03	2.21E+02	2.18E+02	1.579	
21	2.80E-03	1.68E+02	1.70E+02	-0.975	
22	2.85E-03	1.72E+02	1.67E+02	3.213	

R: 152. X: 0. Y: 152. DL: 305. REQ: 169. CF: 1.0000
TDHZ ARRAY, 22 DATA POINTS, RAMP: 210.0 MICROSEC, DATA: M1N1E
2004 001N 001E Z OPR XTL L 6 8+100
Ch.21 = 0.21 Ch.22 = 0.89 Ch.23 = 19 Ch.24 = 92
RMS LOG ERROR: 1.29E-02, ANTILOG YIELDS 3.0072 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.56				
P 2	-0.26	0.65			
P 3	0.14	-0.10	0.57		
T 1	0.15	0.12	-0.04	0.94	
T 2	0.17	0.17	0.03	0.07	-0.88


M1N1E
MODEL:
APPARENT RESISTIVITY (OHM-M)
10^6
10^5
10^4
1000
100
10^-5
10^-4
0.001
0.01
0.1
TIME (SEC)
1085.
OHM-M
258. M
89.5
OHM-M
176. M
2.52
OHM-M
Blackhawk Geosciences, Incorporated
% ERROR: 3.01
CALIBRATION: 1
OFFSET: 152. M
RAMP: 210.0

MT4N2E

MODEL: 2 LAYERS

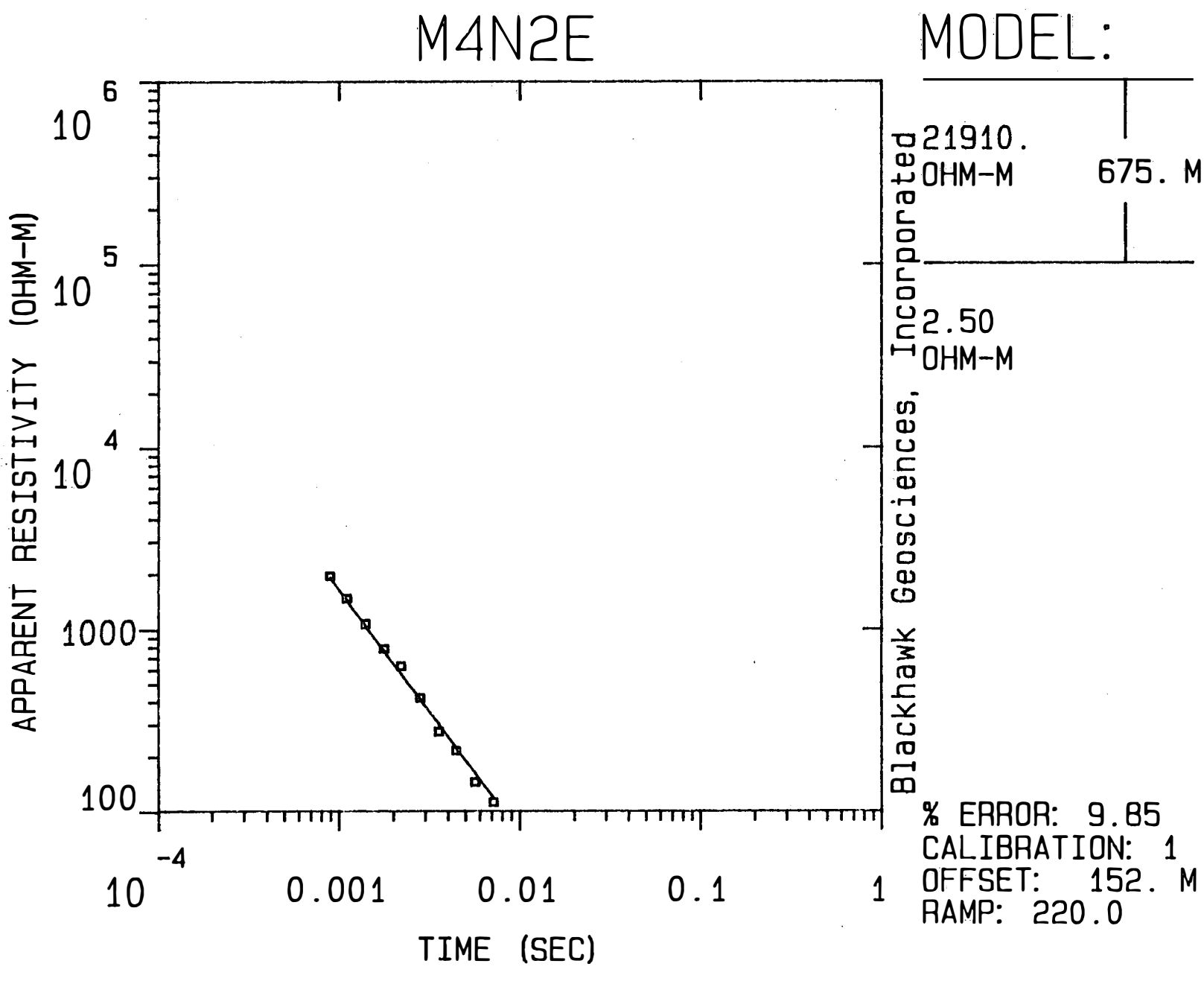
RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	ELEVATION (FEET)	CONDUCTANCE (S) LAYER	CONDUCTANCE (S) TOTAL
		579.1	1900.0		
28038.25	692.2	-113.1	-371.1	0.0	0.0
2.50					

	TIMES	DATA	CALC	% ERROR	STD ERR
1	8.90E-04	1.94E+03	1.95E+03	-0.459	
2	1.10E-03	1.47E+03	1.46E+03	1.162	
3	1.40E-03	1.07E+03	1.05E+03	2.592	
4	1.77E-03	7.81E+02	7.62E+02	2.518	
5	2.20E-03	6.27E+02	5.68E+02	10.353	
6	2.80E-03	4.19E+02	4.10E+02	2.284	
7	3.55E-03	2.74E+02	2.95E+02	-7.246	
8	4.43E-03	2.16E+02	2.18E+02	-0.858	
9	5.64E-03	1.45E+02	1.57E+02	-7.999	
10	7.13E-03	1.12E+02	1.15E+02	-2.805	

R: 152. X: 0. Y: 152. DL: 305. REQ: 169. CF: 1.0000
TDHZ ARRAY, 10 DATA POINTS, RAMP: 220.0 MICROSEC, DATA: MT4N2E
2604 004N 002E Z OPR XTL L 6 8+100
Ch.21 = 0.22 Ch.22 = 0.89 Ch.23 = 19 Ch.24 = 92
RMS LOG ERROR: 3.27E-02, ANTILOG YIELDS 7.8104 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER
P 1 0.08
F 2 0.00 0.00
T 1 0.00 0.00 1.00
P 1 F 2 T 1


M4N2E
MODEL:
21910.
OHM-M
675. M
2.50
OHM-M
APPARENT RESISTIVITY (OHM-M)
10^6
10^5
10^4
1000
100
10^-4
0.001
0.01
0.1
1
TIME (SEC)
Blackhawk Geosciences, Incorporated
% ERROR: 9.85
CALIBRATION: 1
OFFSET: 152. M
RAMP: 220.0

MT3N2E

MODEL: 2 LAYERS

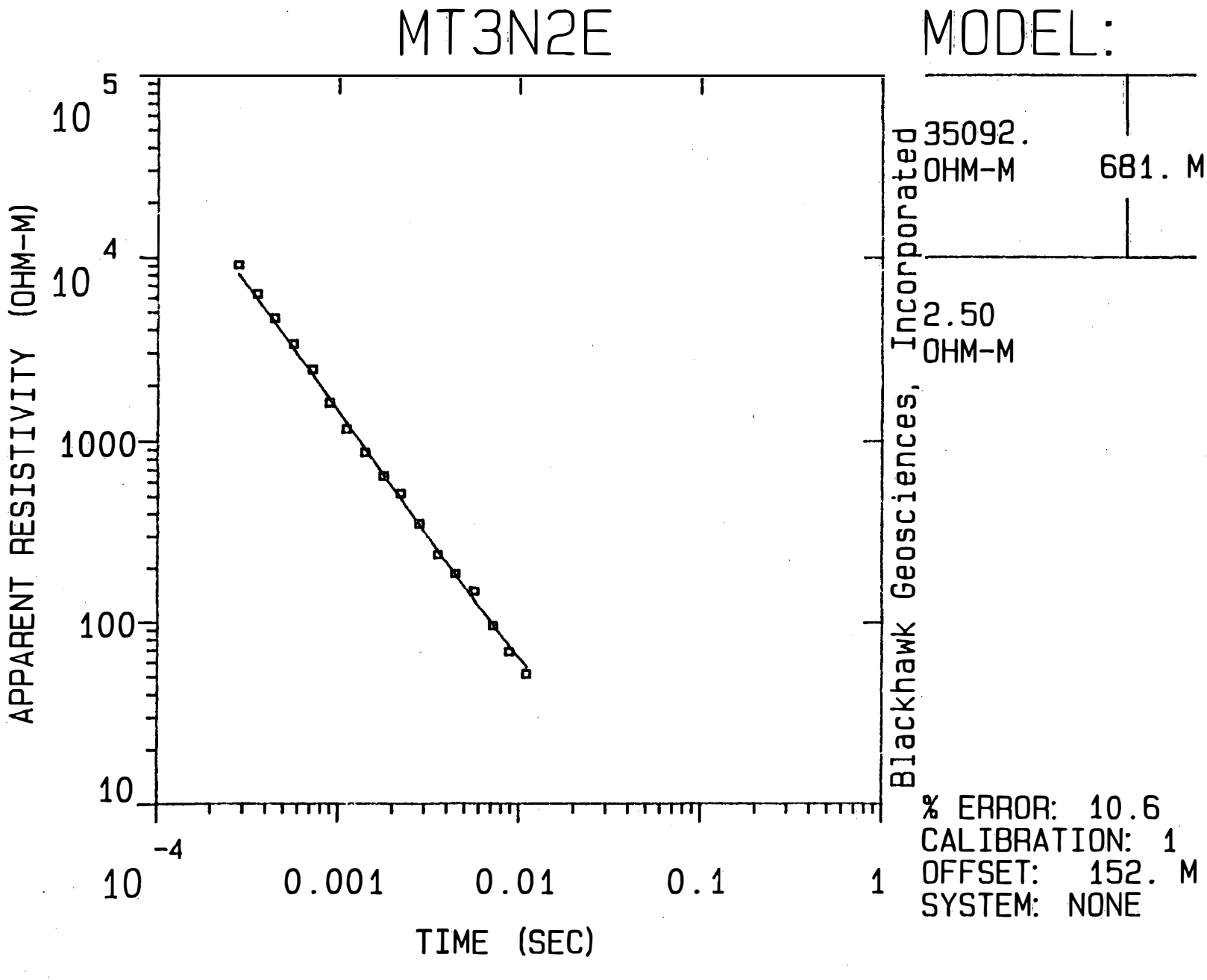
RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	ELEVATION (FEET)	CONDUCTANCE (S) LAYER	CONDUCTANCE (S) TOTAL
		576.1	1890.0		
35091.75	681.3	-105.3	-345.3	0.0	0.0
2.50					

	TIMES	DATA	CALC	% ERROR	STD ERR
1	2.80E-04	9.07E+03	8.05E+03	12.776	
2	3.55E-04	6.28E+03	5.83E+03	7.611	
3	4.43E-04	4.60E+03	4.33E+03	6.327	
4	5.64E-04	3.34E+03	3.12E+03	6.940	
5	7.13E-04	2.43E+03	2.27E+03	6.908	
6	8.90E-04	1.60E+03	1.68E+03	-4.366	
7	1.10E-03	1.16E+03	1.25E+03	-7.373	
8	1.40E-03	8.67E+02	8.99E+02	-3.643	
9	1.77E-03	6.45E+02	6.51E+02	-0.949	
10	2.20E-03	5.18E+02	4.83E+02	7.056	
11	2.80E-03	3.52E+02	3.44E+02	2.215	
12	3.55E-03	2.37E+02	2.47E+02	-3.930	
13	4.43E-03	1.86E+02	1.82E+02	2.024	
14	5.64E-03	1.48E+02	1.31E+02	13.534	
15	7.13E-03	9.56E+01	9.60E+01	-0.513	
16	8.81E-03	6.81E+01	7.26E+01	-6.094	
17	1.10E-02	5.16E+01	5.62E+01	-8.164	

R: 152. X: 0. Y: 152. DL: 305. REQ: 169. CF: 1.0000
TDHZ ARRAY, 17 DATA POINTS, SYSTEM: NONE DATA: MT3N2E
2204 003N 002E Z OPR XTL H 7 8+100
Ch.21 = 0.22 Ch.22 = 0.089 Ch.23 = 19 Ch.24 = 9
RMS LOG ERROR: 4.37E-02, ANTILOG YIELDS 10.5969 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER
P 1 0.42
F 2 0.00 0.00
T 1 -0.16 0.00 0.94
P 1 F 2 T 1


MT3N2E
MODEL:
35092.
OHM-M
681. M
2.50
OHM-M
APPARENT RESISTIVITY (OHM-M)
10^5
10^4
1000
100
10
10^-4
0.001
0.01
0.1
1
TIME (SEC)
Blackhawk Geosciences, Incorporated
% ERROR: 10.6
CALIBRATION: 1
OFFSET: 152. M
SYSTEM: NONE

MT2N2E

MODEL: 2 LAYERS

RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	ELEVATION (FEET)	CONDUCTANCE (S) LAYER	CONDUCTANCE (S) TOTAL
		563.9	1850.0		
9119.18	634.1	-70.2	-230.3	0.1	0.1
2.50					

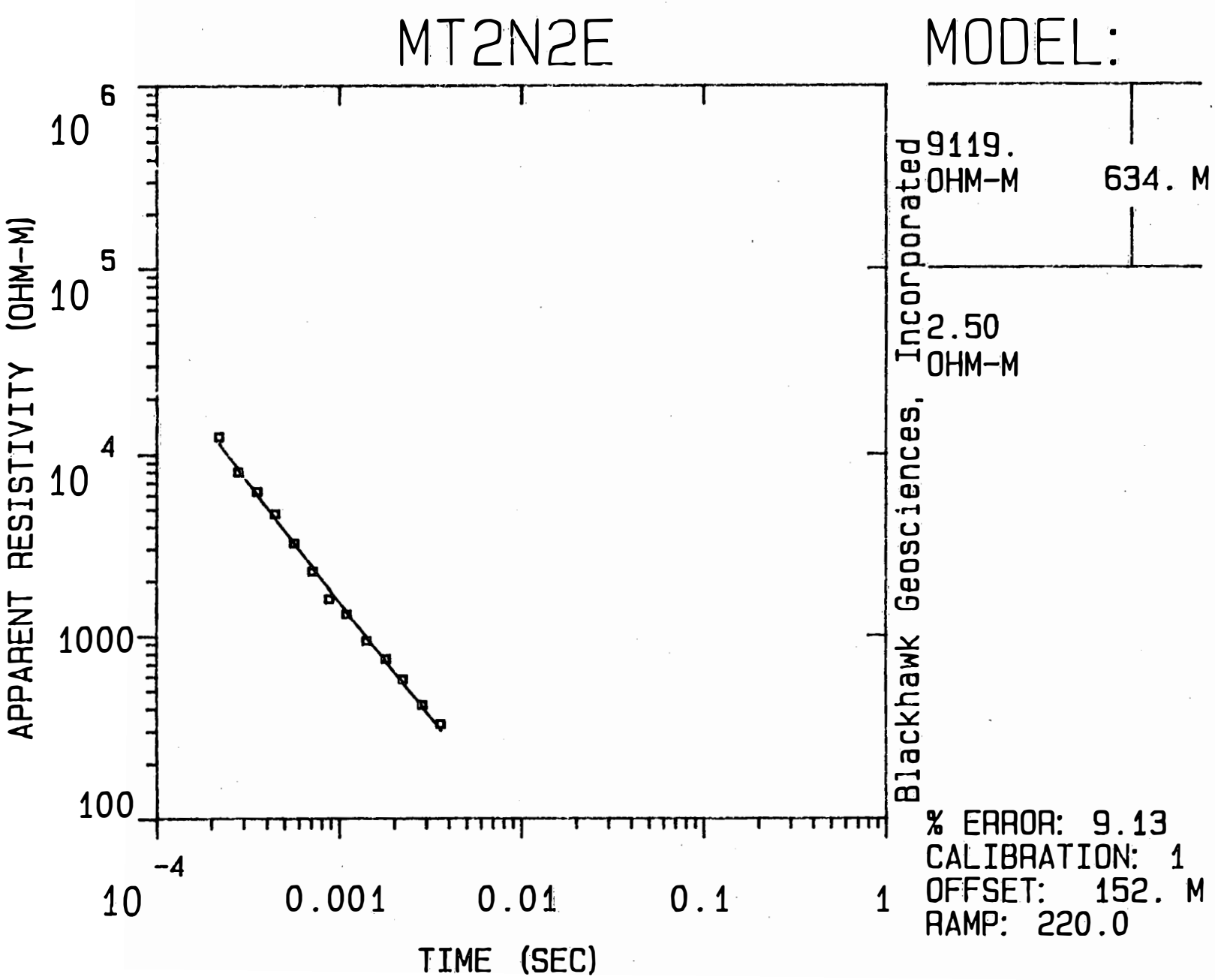
	TIMES	DATA	CALC	% ERROR	STD ERR
1	2.20E-04	1.25E+04	1.15E+04	8.736	
2	2.80E-04	8.02E+03	8.22E+03	-2.547	
3	3.55E-04	6.27E+03	5.95E+03	5.309	
4	4.43E-04	4.71E+03	4.43E+03	6.494	
5	5.64E-04	3.23E+03	3.21E+03	0.662	
6	7.13E-04	2.25E+03	2.36E+03	-4.322	
7	8.81E-04	1.59E+03	1.79E+03	-10.888	
8	1.10E-03	1.31E+03	1.35E+03	-2.429	
9	1.41E-03	9.38E+02	9.74E+02	-3.753	
10	1.80E-03	7.48E+02	7.19E+02	4.092	
11	2.22E-03	5.78E+02	5.49E+02	5.196	
12	2.85E-03	4.19E+02	4.04E+02	3.741	
13	3.60E-03	3.29E+02	3.02E+02	8.700	

R: 152. X: 0. Y: 152. DL: 305. REQ: 169. CF: 1.0000
TDHZ ARRAY, 13 DATA POINTS, RAMP: 220.0 MICROSEC, DATA: MT2N2E
2104 002N 002E Z OPR XTL H 6 8+100
Ch.21 = 0.22 Ch.22 = 0.089 Ch.23 = 19 Ch.24 = 9
RMS LOG ERROR: 3.80E-02, ANTILOG YIELDS 9.1349 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER

P 1	0.73		
F 2	0.00	0.00	
T 1	-0.02	0.00	1.00
	P 1	F 2	T 1


MT2N2E
MODEL:
APPARENT RESISTIVITY (OHM-M)
10^6
10^5
10^4
1000
100
10^-4
0.001
0.01
0.1
1
TIME (SEC)
9119.
OHM-M
634. M
2.50
OHM-M
Blackhawk Geosciences, Incorporated
% ERROR: 9.13
CALIBRATION: 1
OFFSET: 152. M
RAMP: 220.0

MT1N4E

MODEL: 2 LAYERS

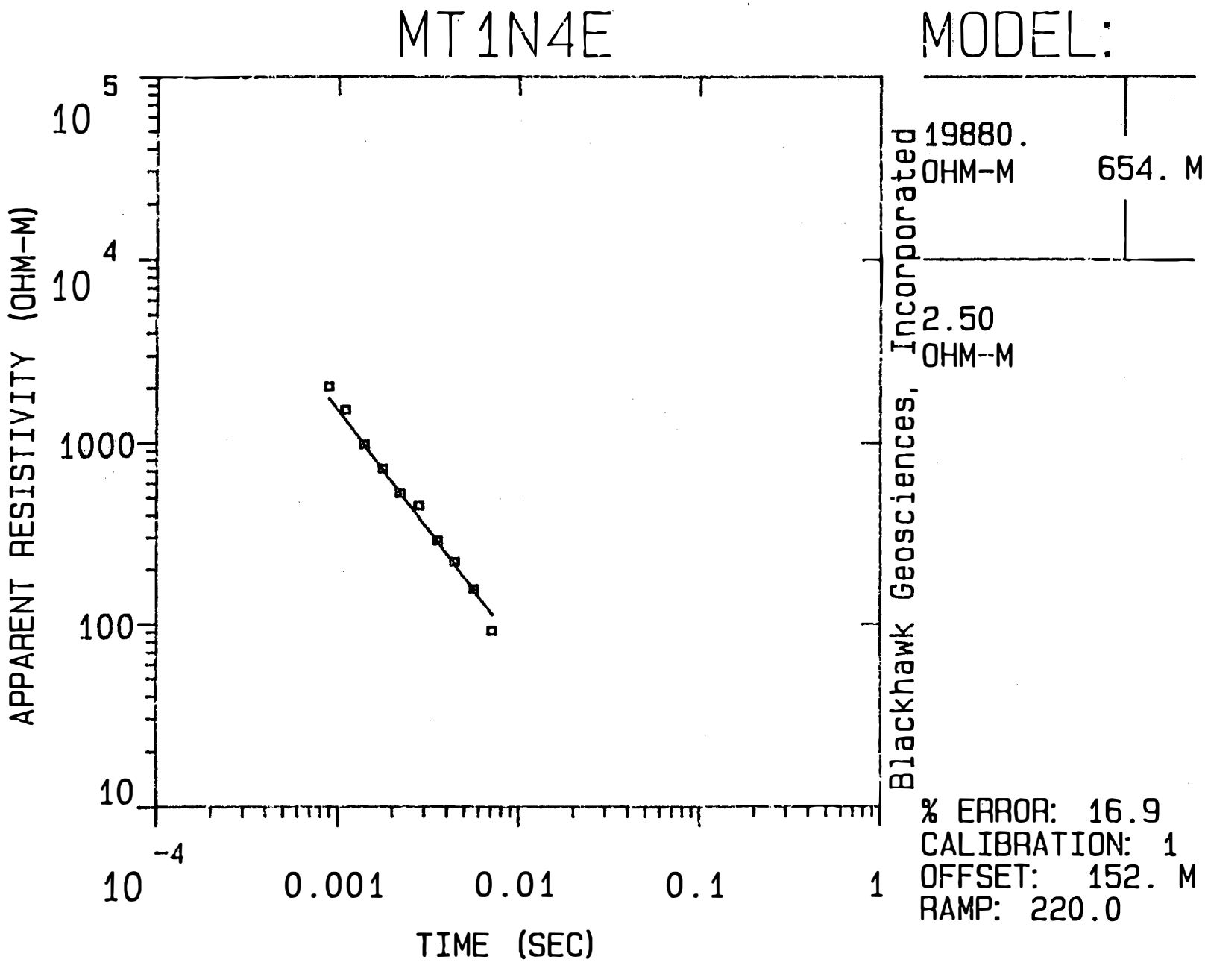
RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	(FEET)	CONDUCTANCE (S) LAYER	TOTAL
		585.2	1920.0		
19879.71	653.5	-68.3	-224.2	0.0	0.0
2.50					

	TIMES	DATA	CALC	% ERROR	STD ERR
1	8.90E-04	2.05E+03	1.76E+03	15.998	
2	1.10E-03	1.52E+03	1.33E+03	14.600	
3	1.40E-03	9.80E+02	9.62E+02	1.896	
4	1.77E-03	7.19E+02	7.02E+02	2.419	
5	2.20E-03	5.29E+02	5.26E+02	0.531	
6	2.80E-03	4.48E+02	3.83E+02	17.046	
7	3.55E-03	2.88E+02	2.81E+02	2.399	
8	4.43E-03	2.20E+02	2.09E+02	5.140	
9	5.64E-03	1.56E+02	1.52E+02	2.569	
10	7.13E-03	9.14E+01	1.11E+02	-17.834	

R: 152. X: 0. Y: 152. DL: 305. REQ: 169. CF: 1.0000
TDHZ ARRAY, 10 DATA POINTS, RAMP: 220.0 MICROSEC, DATA: MT1N4E
2204 001N 004E Z OPR XTL L 6 8-100
Ch.21 = 0.22 Ch.22 = 0.89 Ch.23 = 20 Ch.24 = 92
RMS LOG ERROR: 6.79E-02, ANTILOG YIELDS 16.9218 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER
P 1 0.06
F 2 0.00 0.00
T 1 0.00 0.00 1.00
P 1 F 2 T 1


MT1N4E
MODEL:
APPARENT RESISTIVITY (OHM-M)
10^5
10^4
1000
100
10
10^-4
0.001
0.01
0.1
1
TIME (SEC)
19880.
OHM-M
654. M
2.50
OHM--M
Blackhawk Geosciences, Incorporated
% ERROR: 16.9
CALIBRATION: 1
OFFSET: 152. M
RAMP: 220.0

MT1N2E

MODEL: 2 LAYERS

RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	ELEVATION (FEET)	CONDUCTANCE (S) LAYER	CONDUCTANCE (S) TOTAL
		560.8	1840.0		
1070.78	663.0	-102.2	-335.2	0.6	0.6
2.50					

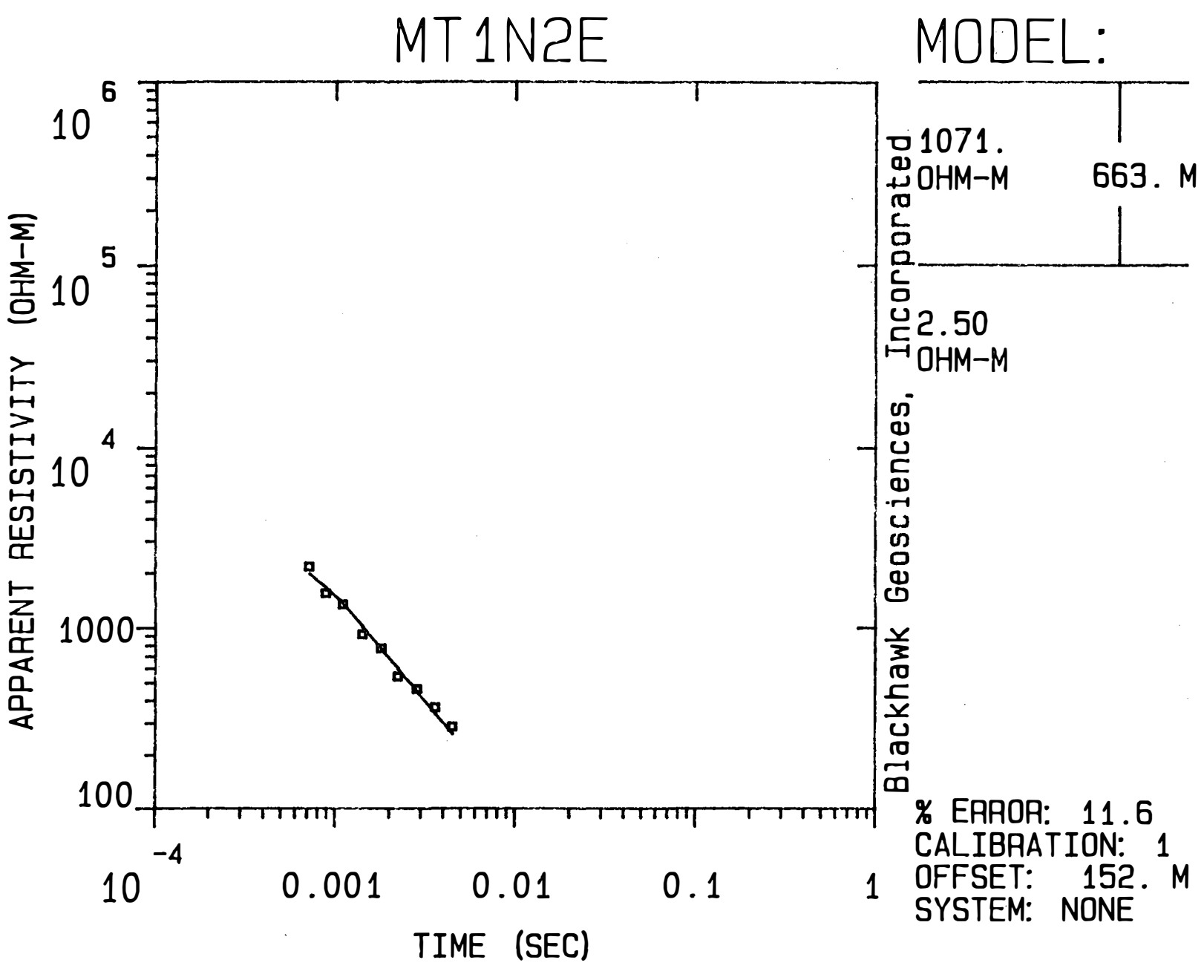
	TIMES	DATA	CALC	% ERROR	STD ERR
1	7.13E-04	2.16E+03	1.97E+03	9.377	
2	8.81E-04	1.54E+03	1.64E+03	-6.240	
3	1.10E-03	1.34E+03	1.36E+03	-1.611	
4	1.41E-03	9.17E+02	1.01E+03	-9.282	
5	1.80E-03	7.71E+02	7.62E+02	1.148	
6	2.22E-03	5.43E+02	5.97E+02	-9.034	
7	2.85E-03	4.64E+02	4.47E+02	3.873	
8	3.60E-03	3.70E+02	3.40E+02	8.771	
9	4.49E-03	2.90E+02	2.65E+02	9.560	

R: 152. X: 0. Y: 152. DL: 305. REQ: 169. CF: 1.0000
TDHZ ARRAY, 9 DATA POINTS, SYSTEM: NONE DATA: MT1N2E
2004 001N 002E Z OPR XTL H 6 8+100
Ch.21 = 0.21 Ch.22 = 0.089 Ch.23 = 19 Ch.24 = 9
RMS LOG ERROR: 4.75E-02, ANTILOG YIELDS 11.5618 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER

P 1	0.94		
F 2	0.00	0.00	
T 1	0.00	0.00	1.00
	P 1	F 2	T 1


MT1N2E
MODEL:
1071.
OHM-M
663. M
2.50
OHM-M
APPARENT RESISTIVITY (OHM-M)
10^6
10^5
10^4
1000
100
10^{-4}
0.001
0.01
0.1
1
TIME (SEC)
Blackhawk Geosciences, Incorporated
% ERROR: 11.6
CALIBRATION: 1
OFFSET: 152. M
SYSTEM: NONE

M4N3E

MODEL: 2 LAYERS

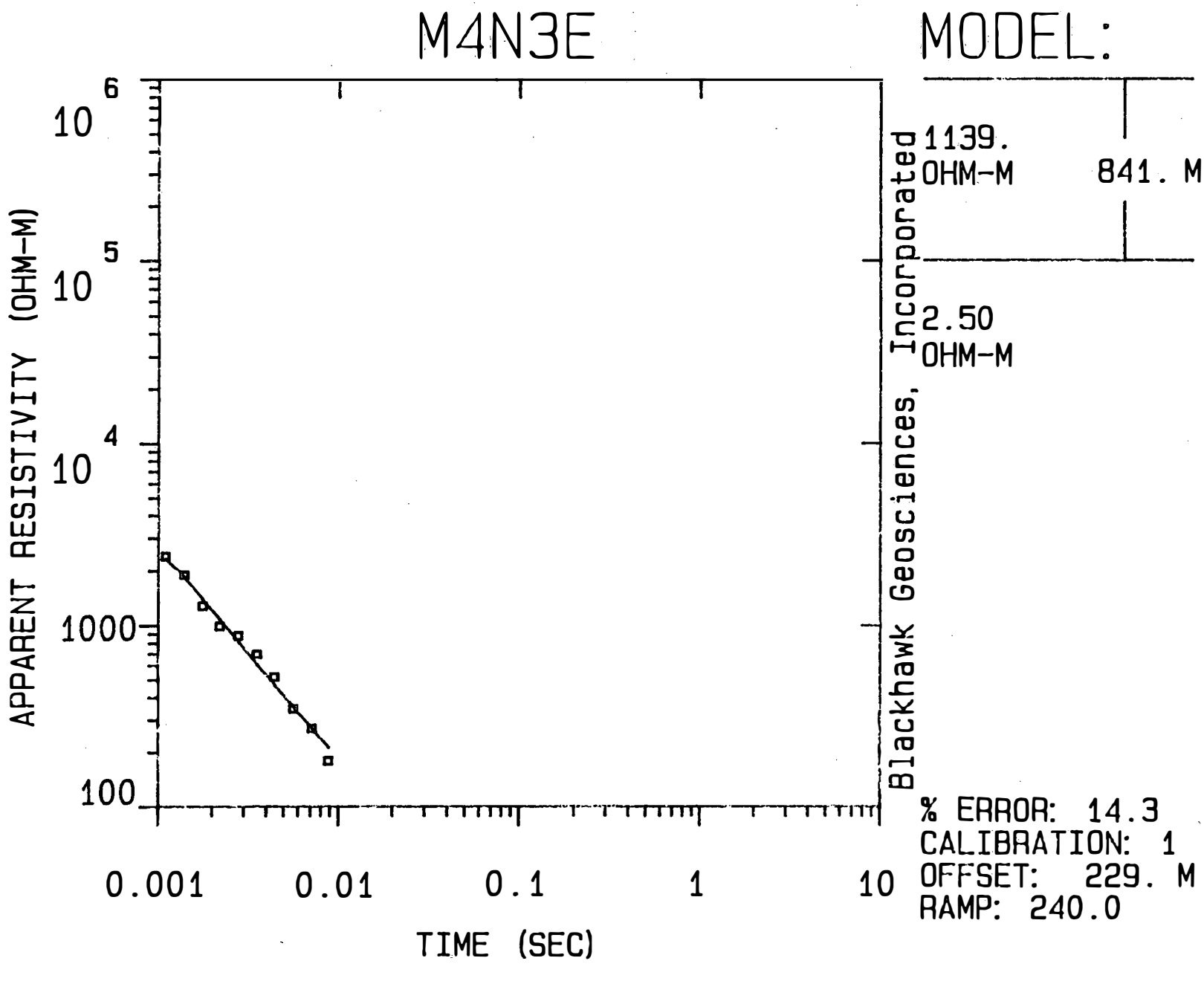
RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	ELEVATION (FEET)	CONDUCTANCE (S) LAYER	CONDUCTANCE (S) TOTAL
		710.2	2330.0		
1138.96	841.5	-131.3	-430.8	0.7	0.7
2.50					

	TIMES	DATA	CALC	% ERROR	STD ERR
1	1.10E-03	2.39E+03	2.32E+03	3.088	
2	1.40E-03	1.90E+03	1.84E+03	3.176	
3	1.77E-03	1.28E+03	1.38E+03	-6.892	
4	2.20E-03	9.92E+02	1.08E+03	-8.261	
5	2.80E-03	8.78E+02	8.12E+02	8.090	
6	3.55E-03	6.96E+02	6.10E+02	14.044	
7	4.43E-03	5.20E+02	4.70E+02	10.752	
8	5.64E-03	3.48E+02	3.55E+02	-1.998	
9	7.13E-03	2.70E+02	2.70E+02	0.220	
10	8.81E-03	1.78E+02	2.12E+02	-16.038	

R: 229. X: 0. Y: 229. DL: 457. REQ: 254. CF: 1.0000
TDHZ ARRAY, 10 DATA POINTS, RAMP: 240.0 MICROSEC, DATA: M4N3E
2604 004N 003E Z OPR XTL L 6 8+100
Ch.21 = 0.24 Ch.22 = 0.89 Ch.23 = 14 Ch.24 = 20
RMS LOG ERROR: 5.80E-02, ANTILOG YIELDS 14.2771 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER
P 1 0.79
F 2 0.00 0.00
T 1 0.01 0.00 1.00
P 1 F 2 T 1


M4N3E
MODEL:
1139.
OHM-M
841. M
2.50
OHM-M
Blackhawk Geosciences, Incorporated
% ERROR: 14.3
CALIBRATION: 1
OFFSET: 229. M
RAMP: 240.0
APPARENT RESISTIVITY (OHM-M)
10^6
10^5
10^4
1000
100
0.001
0.01
0.1
1
10
TIME (SEC)

MT3N3E

MODEL: 2 LAYERS

RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	ELEVATION (FEET)	CONDUCTANCE (S) LAYER	CONDUCTANCE (S) TOTAL
		716.3	2350.0		
38495.46	818.9	-102.7	-336.8	0.0	0.0
2.50					

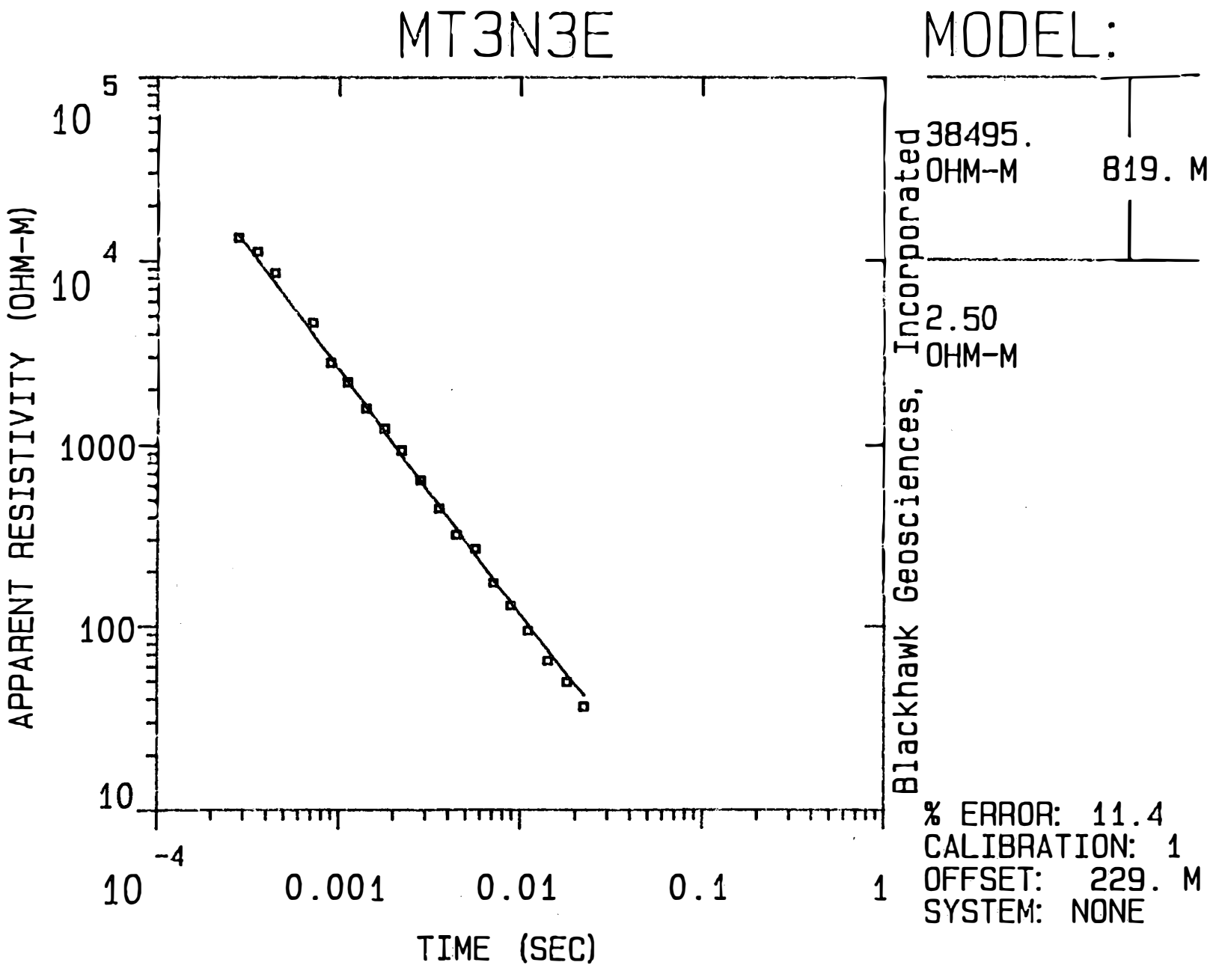
	TIMES	DATA	CALC	% ERROR	STD ERR
1	2.80E-04	1.32E+04	1.36E+04	-3.205	
2	3.55E-04	1.11E+04	9.95E+03	11.404	
3	4.43E-04	8.49E+03	7.43E+03	14.334	
4	7.13E-04	4.57E+03	3.93E+03	16.185	
5	8.90E-04	2.77E+03	2.93E+03	-5.518	
6	8.90E-04	2.77E+03	2.93E+03	-5.518	
7	1.10E-03	2.18E+03	2.21E+03	-1.476	
8	1.10E-03	2.18E+03	2.21E+03	-1.476	
9	1.40E-03	1.57E+03	1.61E+03	-2.243	
10	1.40E-03	1.57E+03	1.61E+03	-2.243	
11	1.77E-03	1.22E+03	1.17E+03	4.420	
12	1.77E-03	1.22E+03	1.17E+03	4.420	
13	2.20E-03	9.32E+02	8.72E+02	6.872	
14	2.20E-03	9.32E+02	8.72E+02	6.872	
15	2.80E-03	6.42E+02	6.32E+02	1.531	
16	2.80E-03	6.42E+02	6.32E+02	1.531	
17	3.55E-03	4.45E+02	4.59E+02	-3.131	
18	3.55E-03	4.45E+02	4.59E+02	-3.131	
19	4.43E-03	3.17E+02	3.42E+02	-7.195	
20	4.43E-03	3.17E+02	3.42E+02	-7.195	
21	5.64E-03	2.66E+02	2.46E+02	8.088	
22	5.64E-03	2.66E+02	2.46E+02	8.088	
23	7.13E-03	1.72E+02	1.78E+02	-3.438	
24	8.81E-03	1.29E+02	1.34E+02	-3.934	
25	1.10E-02	9.39E+01	1.00E+02	-6.420	
26	1.41E-02	6.42E+01	7.25E+01	-11.500	
27	1.80E-02	4.92E+01	5.32E+01	-7.428	
28	2.22E-02	3.65E+01	4.16E+01	-12.370	

R: 229. X: 0. Y: 229. DL: 457. REQ: 254. CF: 1.0000
TDHZ ARRAY, 28 DATA POINTS, SYSTEM: NONE DATA: MT3N3E

Ch.21 = 0.29 Ch.22 = 0.89 Ch.23 = 17.5 Ch.24 =
RMS LOG ERROR: 4.69E-02, ANTILOG YIELDS 11.3964 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER
P 1 0.07


MT3N3E
MODEL:
APPARENT RESISTIVITY (OHM-M)
10^5
10^4
1000
100
10
10^-4
0.001
0.01
0.1
1
TIME (SEC)
38495.
OHM-M
819. M
2.50
OHM-M
Blackhawk Geosciences, Incorporated
% ERROR: 11.4
CALIBRATION: 1
OFFSET: 229. M
SYSTEM: NONE

M2N3E

MODEL: 2 LAYERS

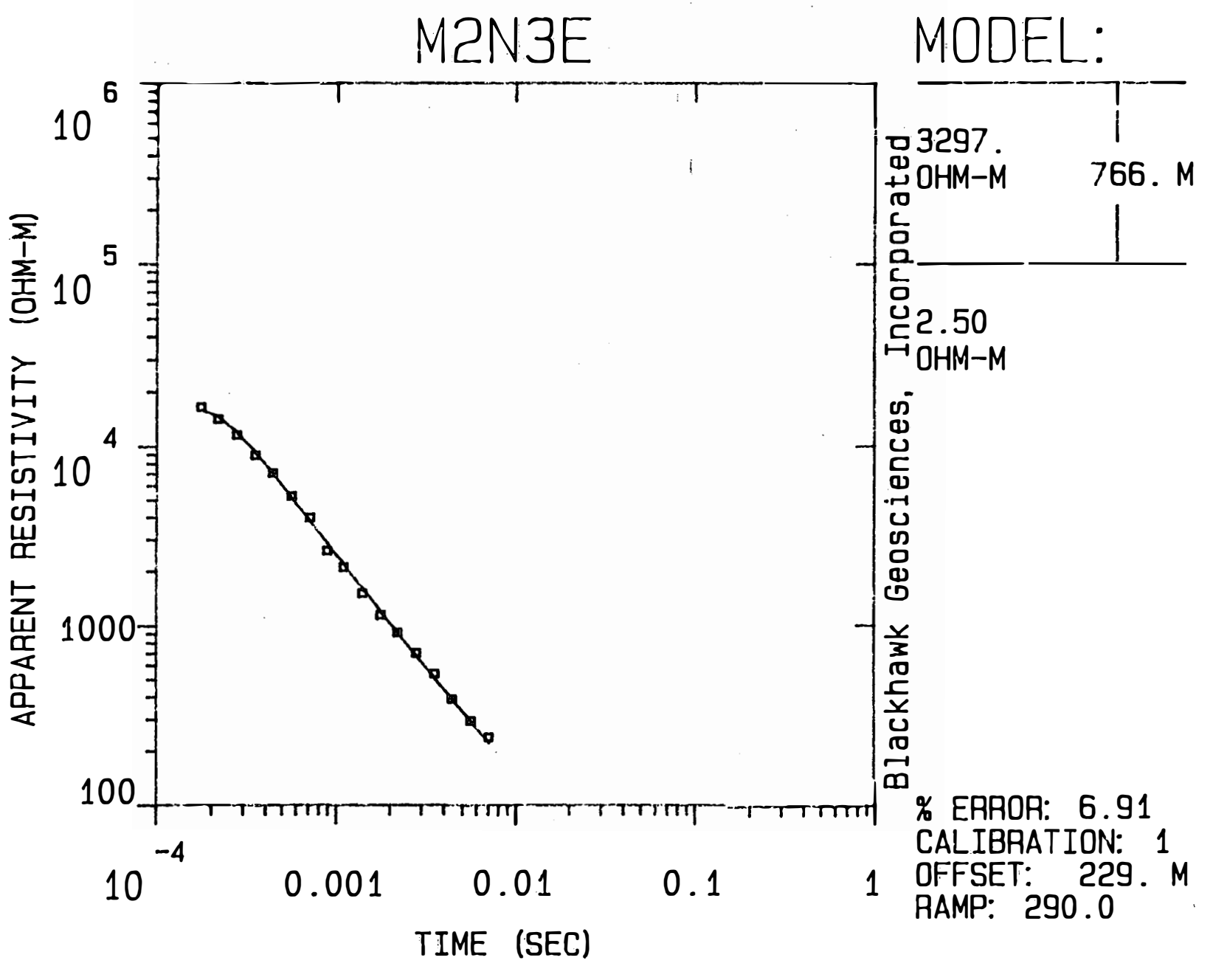
RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	ELEVATION (FEET)	CONDUCTANCE (S) LAYER	CONDUCTANCE (S) TOTAL
		682.8	2240.0		
3296.68	766.1	-83.4	-273.5	0.2	0.2
2.50					

	TIMES	DATA	CALC	% ERROR	STD ERR
1	1.77E-04	1.65E+04	1.60E+04	3.617	
2	2.20E-04	1.42E+04	1.46E+04	-2.530	
3	2.80E-04	1.16E+04	1.19E+04	-2.491	
4	3.55E-04	8.95E+03	9.21E+03	-2.881	
5	4.43E-04	7.10E+03	7.03E+03	1.001	
6	5.64E-04	5.28E+03	5.11E+03	3.347	
7	7.13E-04	3.99E+03	3.79E+03	5.206	
8	8.90E-04	2.60E+03	2.86E+03	-8.934	
9	1.10E-03	2.10E+03	2.18E+03	-3.458	
10	1.40E-03	1.51E+03	1.60E+03	-5.627	
11	1.77E-03	1.15E+03	1.20E+03	-4.180	
12	2.20E-03	9.14E+02	9.09E+02	0.567	
13	2.80E-03	7.03E+02	6.76E+02	3.937	
14	3.55E-03	5.40E+02	5.06E+02	6.590	
15	4.43E-03	3.90E+02	3.88E+02	0.522	
16	5.64E-03	2.94E+02	2.92E+02	0.859	
17	7.13E-03	2.39E+02	2.22E+02	7.846	

R: 229. X: 0. Y: 229. DL: 457. REQ: 254. CF: 1.0000
TDHZ ARRAY, 17 DATA POINTS, RAMP: 290.0 MICROSEC, DATA: M2N3E
2104 002N 003E Z OPR XTL H 6 8+100
Ch.21 = 0.29 Ch.22 = 0.089 Ch.23 = 17 Ch.24 = 2
RMS LOG ERROR: 2.90E-02, ANTILOG YIELDS 6.9112 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER
P 1 0.03
F 2 0.00 0.00
T 1 0.01 0.00 0.49
P 1 F 2 T 1


M2N3E
MODEL:
3297.
OHM-M
766. M
2.50
OHM-M
APPARENT RESISTIVITY (OHM-M)
10^6
10^5
10^4
1000
100
10^-4
0.001
0.01
0.1
1
TIME (SEC)
Blackhawk Geosciences, Incorporated
% ERROR: 6.91
CALIBRATION: 1
OFFSET: 229. M
RAMP: 290.0

M1N3E

MODEL: 2 LAYERS

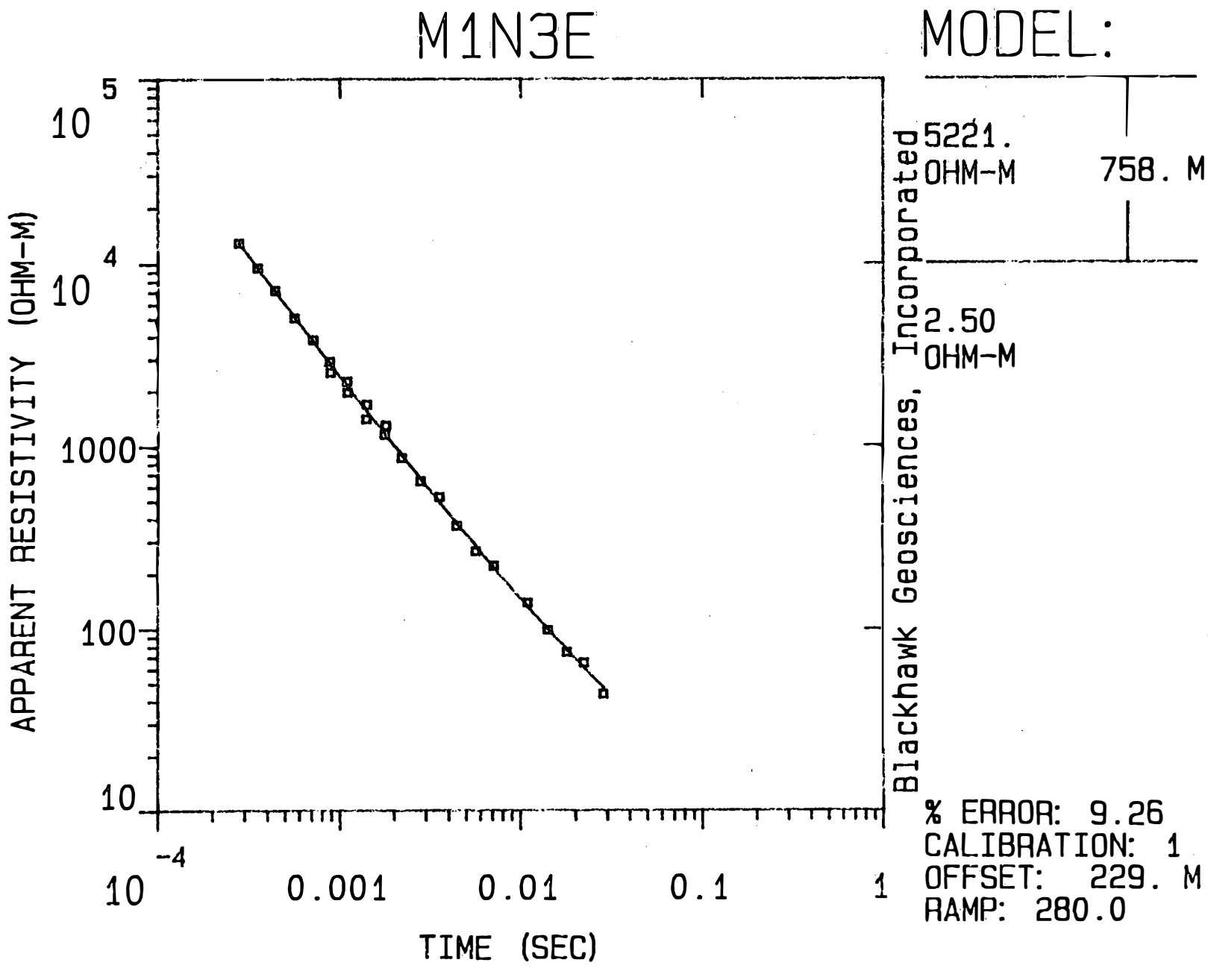
RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	(FEET)	CONDUCTANCE (S) LAYER	TOTAL
		681.2	2235.0		
5220.59	757.9	-76.7	-251.6	0.1	0.1
2.50					

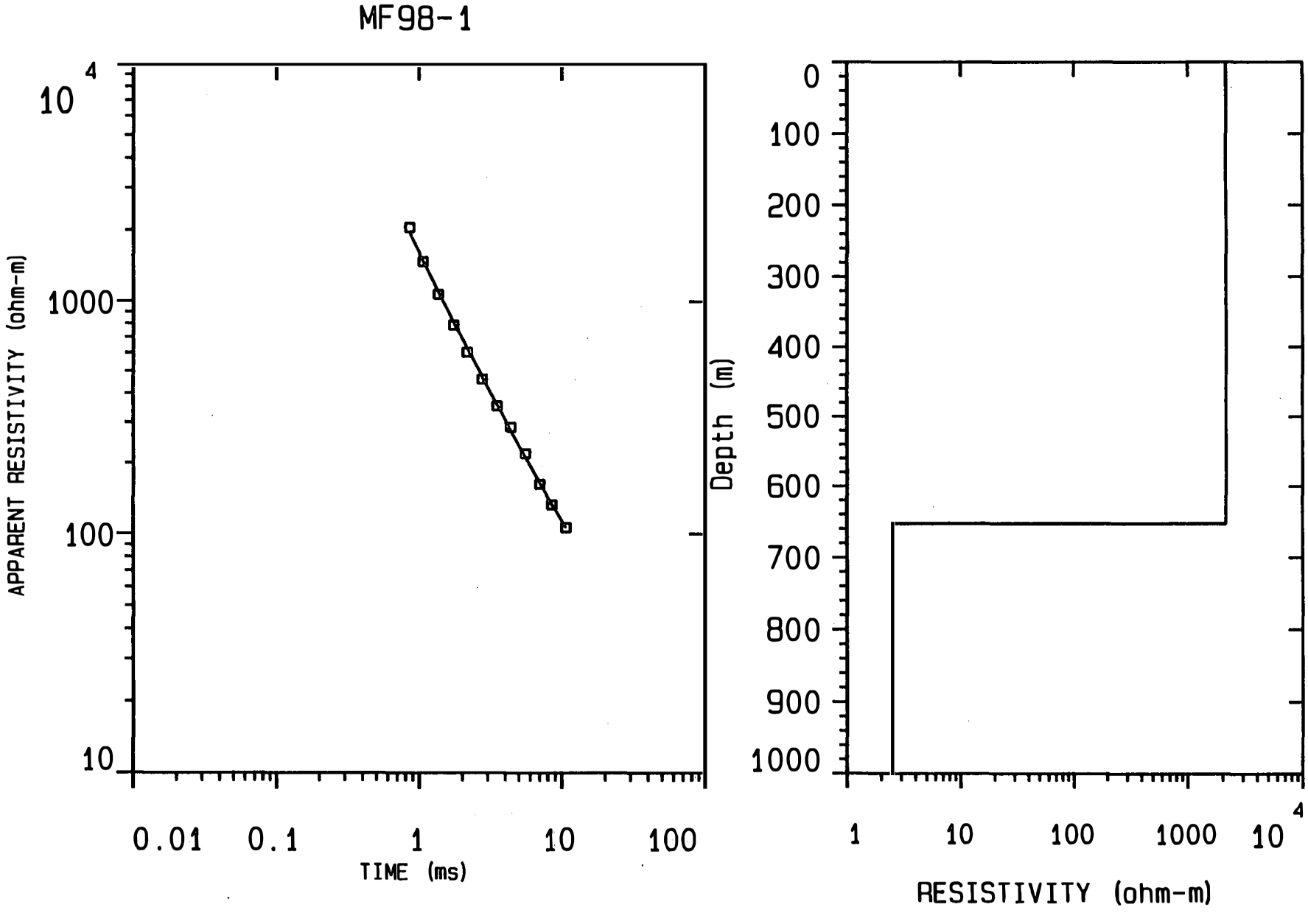
	TIMES	DATA	CALC	% ERROR	STD ERR
1	2.80E-04	1.30E+04	1.30E+04	-0.161	
2	3.55E-04	9.50E+03	9.42E+03	0.938	
3	4.43E-04	7.16E+03	7.03E+03	1.779	
4	5.64E-04	5.06E+03	5.12E+03	-1.048	
5	7.13E-04	3.84E+03	3.75E+03	2.431	
6	8.81E-04	2.93E+03	2.85E+03	2.711	
7	8.90E-04	2.55E+03	2.81E+03	-9.329	
8	1.10E-03	2.28E+03	2.15E+03	5.729	
9	1.10E-03	1.98E+03	2.14E+03	-7.808	
10	1.40E-03	1.41E+03	1.57E+03	-10.263	
11	1.41E-03	1.70E+03	1.55E+03	9.602	
12	1.77E-03	1.15E+03	1.17E+03	-1.173	
13	1.80E-03	1.31E+03	1.15E+03	13.690	
14	2.20E-03	8.62E+02	8.90E+02	-3.118	
15	2.80E-03	6.42E+02	6.59E+02	-2.649	
16	3.55E-03	5.29E+02	4.94E+02	7.040	
17	4.43E-03	3.65E+02	3.77E+02	-3.128	
18	5.64E-03	2.66E+02	2.83E+02	-6.158	
19	7.13E-03	2.21E+02	2.15E+02	2.688	
20	1.10E-02	1.39E+02	1.32E+02	5.723	
21	1.41E-02	9.86E+01	9.94E+01	-0.795	
22	1.80E-02	7.44E+01	7.65E+01	-2.799	
23	2.22E-02	6.51E+01	6.10E+01	6.694	
24	2.85E-02	4.38E+01	4.72E+01	-7.126	

R: 229. X: 0. Y: 229. DL: 457. REQ: 254. CF: 1.0000
TDHZ ARRAY, 24 DATA POINTS, RAMP: 280.0 MICROSEC, DATA: M1N3E
2104 001N 003E Z OPR XTL H 6 8+100
Ch.21 = 0.28 Ch.22 = 0.089 Ch.23 = 17.5 Ch.24 =
RMS LOG ERROR: 3.84E-02, ANTILOG YIELDS 9.2553 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER
P 1 0.62
F 2 0.00 0.00
I 1 0.00 0.00 1.00


M1N3E
MODEL:
APPARENT RESISTIVITY (OHM-M)
10^5
10^4
1000
100
10
10^-4
0.001
0.01
0.1
1
TIME (SEC)
5221.
OHM-M
758. M
2.50
OHM-M
Blackhawk Geosciences, Incorporated
% ERROR: 9.26
CALIBRATION: 1
OFFSET: 229. M
RAMP: 280.0


MF98-1
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
0.01
0.1
1
10
100
TIME (ms)
Depth (m)
0
100
200
300
400
500
600
700
800
900
1000
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: MF98-1

CLIENT: MACFARMS OF HAWAII DATE: 10-05-98
LOCATION: HONOMALINO SOUNDING: 1E
COUNTY: SOUTH KONA ELEVATION: 567.00 m
PROJECT: TDEM SURVEY EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 305.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 1.0000 N: 100.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 4.274 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	(FT)	CONDUCTANCE (Siemens)
			567.0	1860	
1	2148.7	652.8	-85.89	-282	0.303
2	2.50 *				

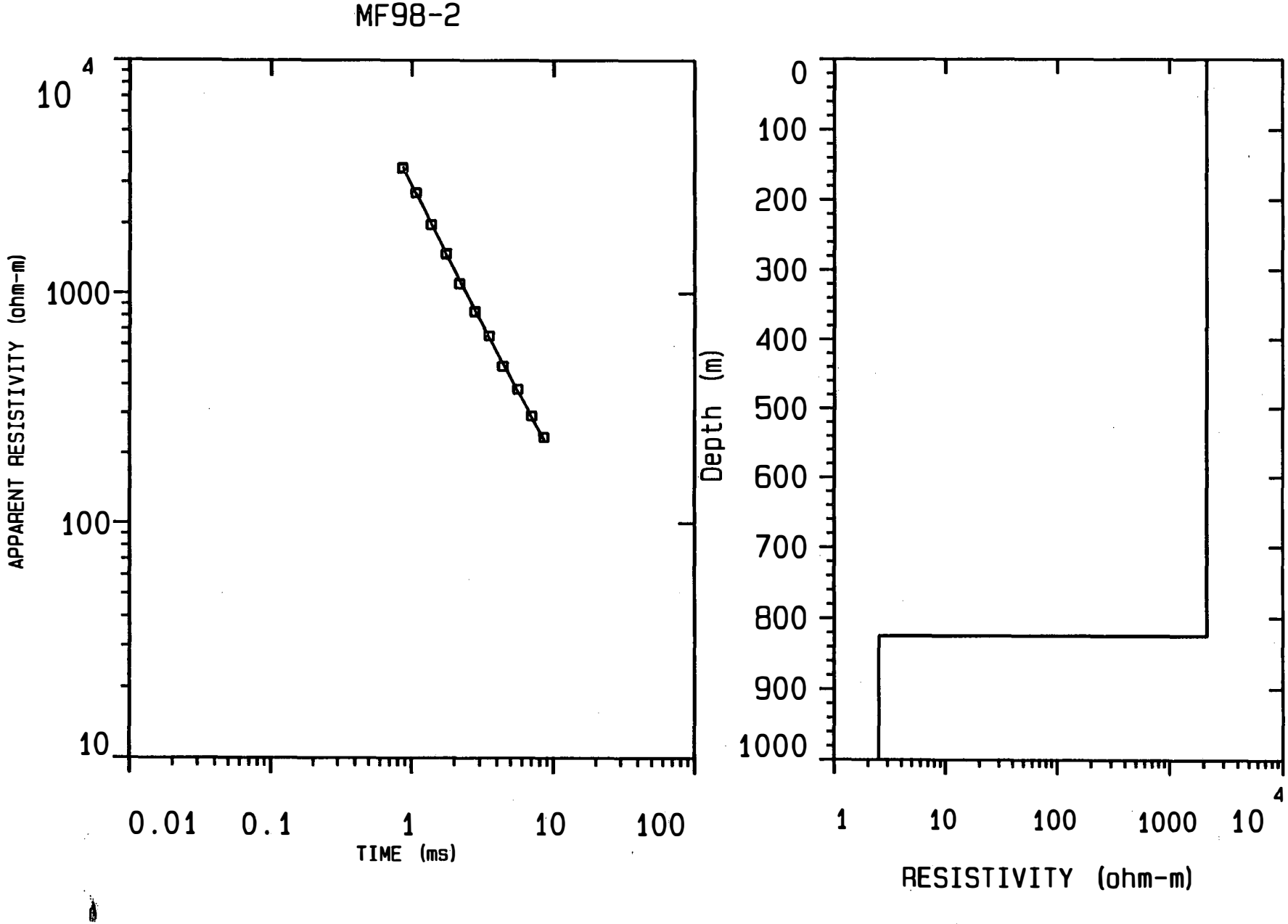
"*" INDICATES FIXED PARAMETER

CURRENT: 14.70 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 165.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.857	10.85	11.79	-8.68
2	1.06	10.37	10.28	0.874
3	1.37	8.90	8.67	2.62
4	1.74	7.76	7.39	4.85
5	2.17	6.65	6.32	5.07
6	2.77	5.42	5.30	2.33
7	3.50	4.49	4.44	1.21
8	4.37	3.53	3.73	-5.54
9	5.56	2.87	3.06	-6.50
10	6.98	2.57	2.52	2.22
11	8.56	2.09	2.09	0.125
12	10.64	1.70	1.70	0.00233

PARAMETER RESOLUTION MATRIX:

```
"F" INDICATES FIXED PARAMETER
P 1   0.03
F 2   0.00   0.00
T 1   0.01   0.00   1.00
        P 1    F 2    T 1
```


MF98-2
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
0.01
0.1
1
10
100
TIME (ms)
Depth (m)
0
100
200
300
400
500
600
700
800
900
1000
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: MF98-2

CLIENT: MACFARMS OF HAWAII DATE: 10-07-98
LOCATION: HONOMALINO SOUNDING: 2
COUNTY: SOUTH KONA ELEVATION: 696.50 m
PROJECT: TDEM SURVEY EQUIPMENT: Geonics PROTEM
LOOP SIZE: 518.000 m by 518.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 2.0000 N: 100.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 2.610 PERCENT

L #	RESISTIVITY (ohm-m)		THICKNESS (meters)	ELEVATION (meters)	(FT)	CONDUCTANCE (Siemens)
				696.5	2285	
1	2135.7		825.0	-128.5	-422	0.386
2	2.50	*				

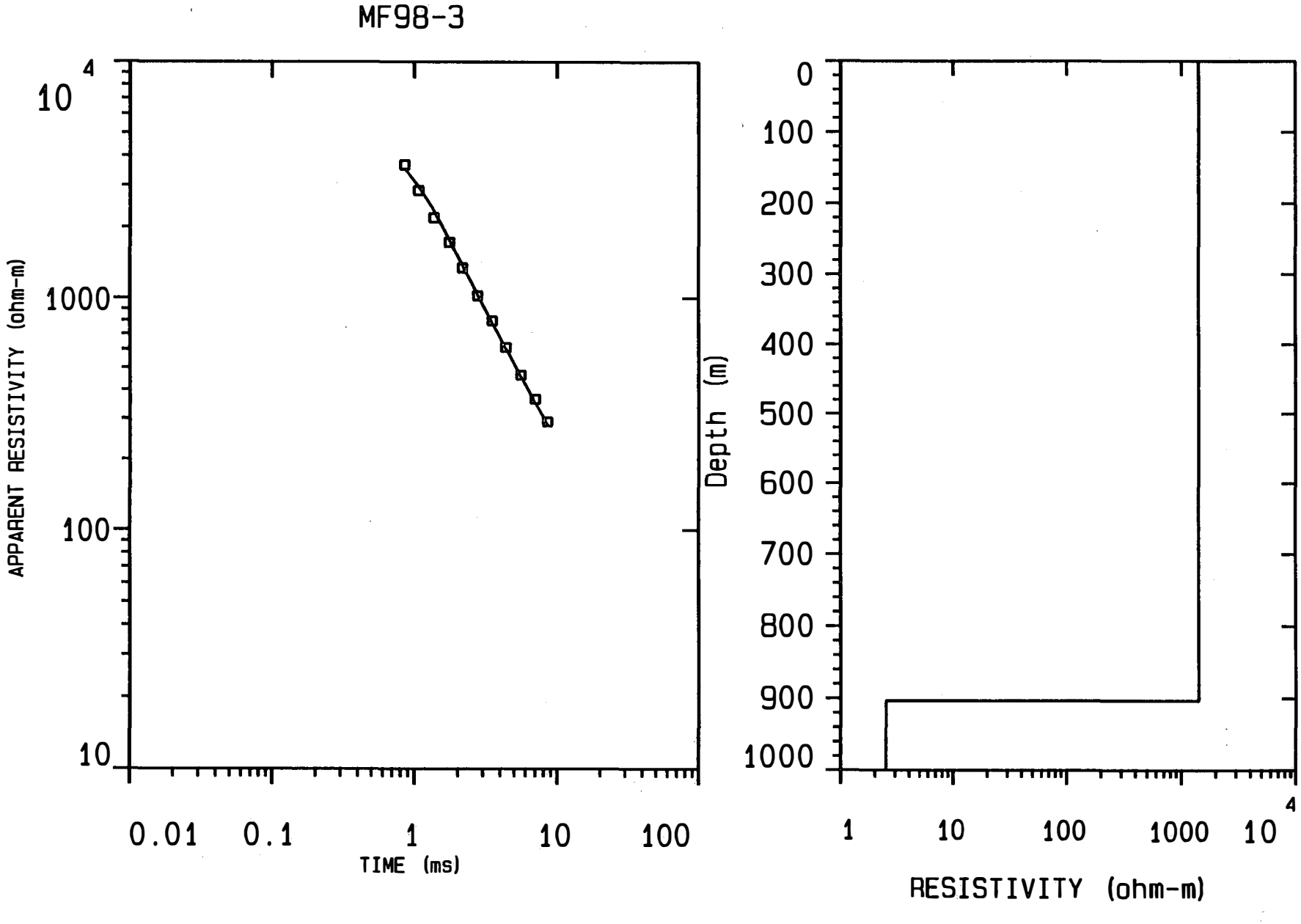
"*" INDICATES FIXED PARAMETER

CURRENT: 13.50 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 6 RAMP TIME: 220.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.857	13.14	12.93	1.62
2	1.06	11.04	11.15	-0.946
3	1.37	9.42	9.37	0.500
4	1.74	8.02	8.02	0.0129
5	2.17	7.19	6.87	4.50
6	2.77	5.92	5.80	1.92
7	3.50	4.74	4.90	-3.32
8	4.37	4.29	4.15	3.26
9	5.56	3.34	3.45	-3.08
10	6.98	2.82	2.87	-1.67
11	8.56	2.33	2.41	-3.29

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

```
P 1  0.16
F 2  0.00  0.00
T 1  0.01  0.00  1.00
       P 1   F 2   T 1
```


MF98-3
APPARENT RESISTIVITY (ohm-m)
10^4
1000
100
10
0.01
0.1
1
10
100
TIME (ms)
Depth (m)
0
100
200
300
400
500
600
700
800
900
1000
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

DATA SET: MF98-3

CLIENT: MACFARMS OF HAWAII DATE: 10-08-98
LOCATION: HONOMALINO SOUNDING: 3
COUNTY: SOUTH KONA ELEVATION: 762.00 m
PROJECT: TDEM SURVEY EQUIPMENT: Geonics PROTEM
LOOP SIZE: 518.000 m by 518.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 3.0000 N: 100.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 4.924 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	(FT)	CONDUCTANCE (Siemens)
			762.0	2500	
1	1417.9	903.1	-141.1	-463	0.636
2	2.50 *				

"*" INDICATES FIXED PARAMETER

CURRENT: 13.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 230.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.857	11.60	12.34	-6.40
2	1.06	9.77	9.18	6.08
3	1.37	7.76	7.06	9.03
4	1.74	6.11	5.90	3.56
5	2.17	5.12	4.97	2.91
6	2.77	4.19	4.16	0.716
7	3.50	3.39	3.51	-3.33
8	4.37	2.89	2.96	-2.17
9	5.56	2.39	2.46	-2.55
10	6.98	1.94	2.04	-4.91
11	8.56	1.64	1.72	-4.48

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

```
P 1  0.92
F 2  0.00  0.00
T 1  0.00  0.00  1.00
       P 1   F 2   T 1
```